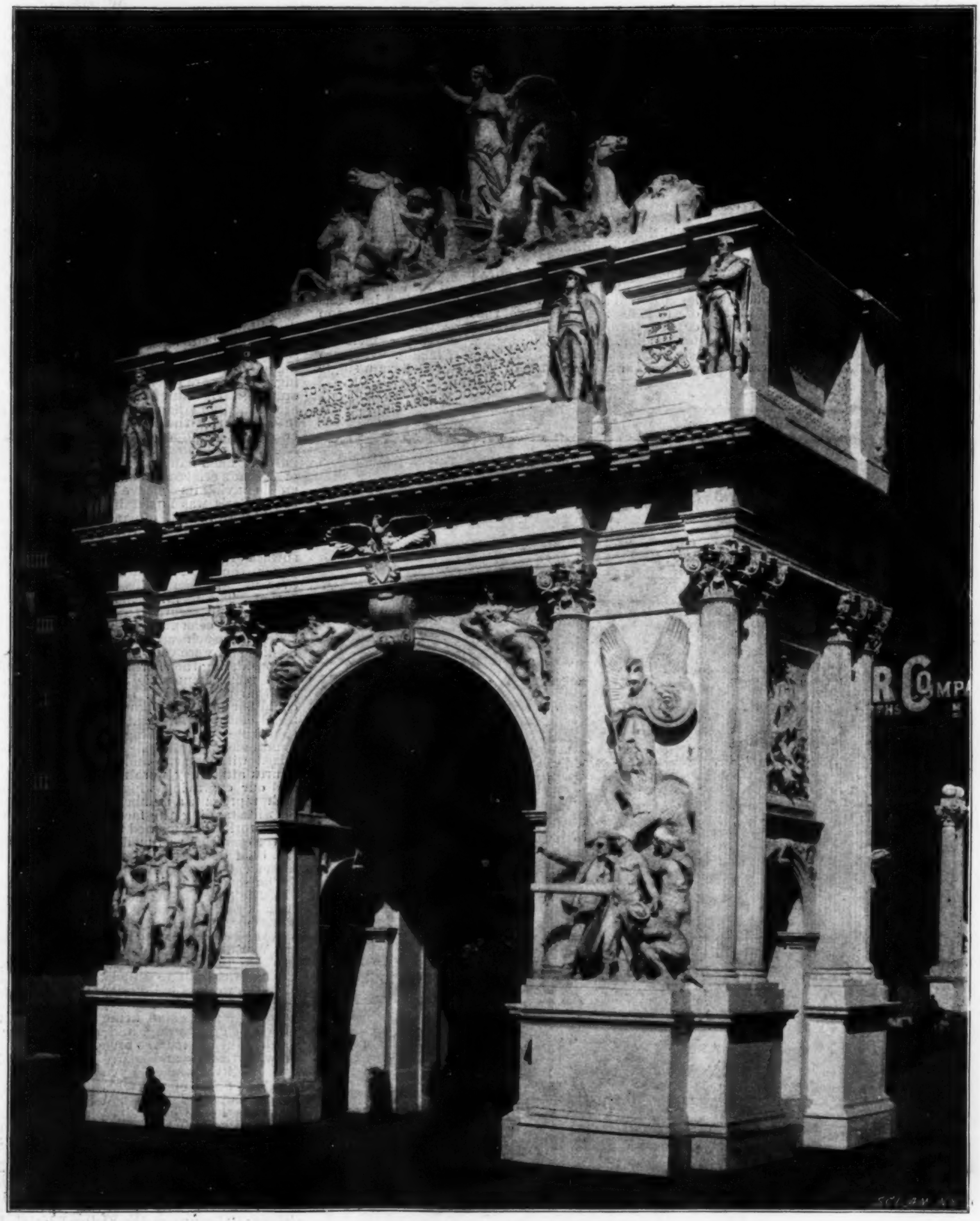
SCIENTIFIC AMERICAN SUPPLEMENT. No 1241

Scientific American. established 1845.
Scientific American Supplement. Vol. XLVIII. No. 1241.

NEW YORK, OCTOBER 14, 1899.

Scientific American Supplement. $5 a year.
Scientific American and Supplement. $7 a year.



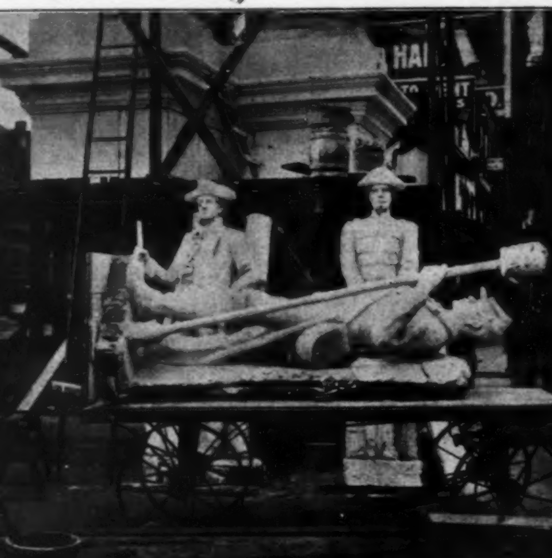
THE DEWEY ARCH, MADISON SQUARE, NEW YORK CITY.

THE DEWEY ARCH.

THE National Sculpture Society has done a noble work in building the Dewey Arch in New York city for the celebration which has just passed. In the SCIENTIFIC AMERICAN for September 16 we described the modeling of the figures for the Dewey Arch, and we are now able to present some further views of the construction and also illustrations of the arch and the completed groups.

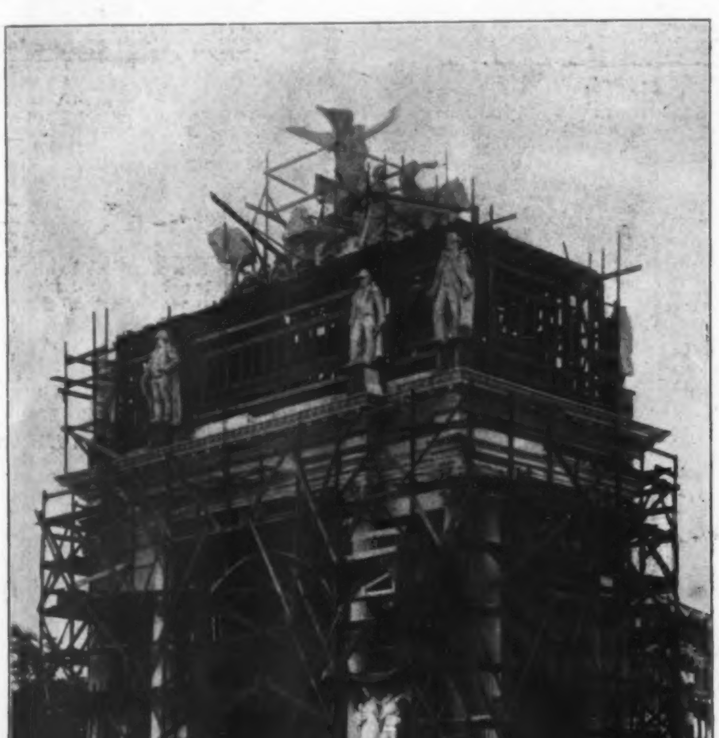
When it was known that Admiral Dewey would land in New York, that city determined to make his arrival the occasion for a demonstration in his honor worthy of the great municipality and the whole country. Mr. Charles Rollinson Lamb, second vice-president of the National Sculpture Society, proposed to the president of that body, Mr. J. Q. A. Ward, that the sculptor members be requested to make plans for the decoration with sculpture of a triumphal arch, which has been considered at all times the greatest tribute which can be paid to a returning victor. The scheme was warmly indorsed by the sculptors, who volunteered to do their share of the work without expense to the city. After almost insuperable difficulties had been overcome, the president of the Sculpture Society called upon the artists, and they responded with quick and patriotic heartiness to the demand for their services. A model of the arch with its groups was made, and estimates of the cost were presented to the city officials, and the committees in charge. Finally all difficulties were smoothed away, and the sculptors could begin their work. The managers of Madison Square Garden gave the basement of their great building free of charge for the work. Mr. Charles R. Lamb was architect of the arch, and his design was approved by the prominent sculptors and architects. The sculptors necessarily had to work in unison, for in a work of such dimensions and with so many differing temperaments in the artistic body, it was essential to co-operate as closely as possible. The result of their labors was most admirable. It fulfills its purpose as a decorative creation, and it is to be hoped that it will be perpetuated in permanent material.

The arch is not, properly speaking, in the axis of Fifth Avenue, and the reason for this is easily explained. The arch must be at least as large as it is to give the required impression of mass and dignity in its place in Madison Square. If it were set in the axis of Fifth Avenue, its westerly pier would cover the Broadway car tracks and would almost block traffic in that important thoroughfare. It was therefore set with its easterly side in line with the façades of the buildings which line Fifth Avenue on the east and with its westerly side in line with the Fifth Avenue curve on the west. Properly speaking, the arch has neither front nor back. The north and south sides are identical except the subjects of the groups and single figures are different. The quadriga which surmounts the whole construction faces south. The arch and colonnade is 78½ feet wide and 510 feet long. It consists of a central arch with a clear space of 28 feet and the rise is 41 feet, and the extreme height is nearly 100 feet. On each side of it is an approach formed of double rows of columns. The arch is pierced by smaller arches at right angles to the main one in the line of Twenty-fourth Street, and the sides are treated similarly to the main front. The surfaces are all richly paneled and decorated with bass-reliefs, inscriptions, statues in the round and groups. The arch was intended primarily as a decoration for the parade and was not intended as a permanent structure. It was necessary, however, to build the arch in such a manner that it would have considerable stability and so that it would remain intact for several months.



TRANSPORTING THE HEROIC STAFF FIGURES.

The arch itself consists of a framework of vertical timbers with all the panels X-braced and with horizontal, longitudinal and transverse struts at vertical intervals of 6 to 10 feet. At the top of the cornice and at the top of the attic are two horizontal floors which act as stiffening diaphragms. The symmetrical corner piers are each 14 feet 2¼ inches by 16 feet 10¼ inches. They are connected above the top of the arch to form a single tower 25 × 59½ feet. All the timber used in the construction was yellow pine, and the total weight with sculpture and plaster was not far from 100 tons.



THE DEWEY ARCH IN PROCESS OF ERECTION.

The "Arch of Titus" at Rome was taken as being the best ancient example to richly decorate with sculpture, and it was modified to meet special conditions. The Dewey Arch was enlarged from the classic prototype. Instead of being supported on two piers, a new penetration was given east and west. Extra columns have been added to the side, giving two groups of two columns each, thus making a motive for the colonnade. The arch symbolizes Naval Victory, and in its groups are portrait-statues and groups representative of the power and fame of the United States as a nation that has won honor on the sea. All the exterior surface of the arch, piers and attic are completely covered with ornamental plaster of Paris fastened on in sections, so that the effect is that of a solid mass of white marble. The plaster veneer is made in sections which are straight or curved as the case may be, and after being cast they are secured in place and the joints are rendered imperceptible by pointing up. The groups were modeled full size in one part of the basement of Madison Square Garden, and the architectural features were made on the other side of the basement of the building. There are forty columns in the arch and the colonnade; all are duplicates and are 29 feet high. They are 37 inches in diameter at the base and are 35 inches in diameter at the top, and each shaft was made in two lengths and each length was split through the axis and made into two semi-cylindrical, longitudinal halves. Each half was made in a trough-like mould of Keene's cement with a light wooden framework or cradle having its concave surface polished. The plaster of Paris was mixed in tubs and poured into the mould with the aid of pans. The mould was greased to prevent adhesion. Alternate flowings and scrapings were continued until a thin coat was formed over the surface of the mould. Long strips of burlap were then put on the plaster, and more plaster was then spread over it. Wooden strips helped to tie the whole together. The separate halves of the columns were set in place and secured together temporarily. Vertical seams were cemented with wet plaster. The decorative work, such as capitals, etc., were cast in glue moulds and were very light.

Considering the enormous amount of sculpture, it almost seems impossible for the enormous arch to be built in the space of six short weeks. Of course, it could not have been done if that beautiful plastic material called "staff" had not been used. It is a cheap substitute for something more durable and presents a handsome appearance. It consists of plaster of Paris mixed with cement and fibrous materials. The staff figures after they were made were placed in position, and our engraving which shows the progress of the arch represents a number of groups in actual position, notwithstanding the fact that much of the architectural work still remained to be done. Part of the group of the quadriga was modeled in place. The following is a brief description of the process of making the enlargements.

The sculptor makes his model in his studio, generally 2 or 3 feet high; he then obtains a plaster model from it, and this was taken to Madison Square Garden, where it was enlarged under the direction of Carl Beil, who had charge of the men who did the same work at the World's Fair. Usually the head and hands were modeled full size in the sculptor's studio. A wooden carcass was built to support the head and hands, and then the work of building up the man 12 feet high was begun. All of the trunk and legs are outlined with wire netting, the staff being applied over this. Pieces of wire cloth, burlap, and even excelsior were freely used. The plaster was brought in pans and was applied with trowels and coarse modeling tools. Drapery was readily obtained by using burlap dipped in the plaster. Some of the sculptors did their own work, others employed professional modelers. The proportions are kept with calipers and by means of plumb lines and scales which correspond to the ruled squares of a painter's cartoon. There is not very much finishing, except to face and hands, and the bodies were freely shaped with hatchets and rasps. Some of the figures were modeled full size.

The great groups on the front of the piers are the "Call to Arms" by P. Martiny; "Combat" by Karl Bitter; "Return of the Victors" by C. H. Niehaus; and "Peace" by Daniel C. French. Above these on the attic acting as finials to the eight columns are full length figures of heroic size of the great figures in American naval history. Commodore Paul Jones by E. C. Potter, Commodore Hull by H. K. Bush-Brown, Commodore Perry by J. S. Hartley, Commodore Decatur by G. L. Brewster, Commodore Macdonough by Thomas S. Clarke, Admiral Farragut by W. O. Part-

ridge, Admiral Porter by J. J. Boyle, and Cushing by A. Lukeman. The remainder of the attic is taken up by symbolic panels and inscriptions. The four spandrels over the main entrance have bass-reliefs symbolizing the Atlantic and Pacific Oceans on the north by R. H. Perry, and the North and East Rivers on the south by I. Konti. The keystones of the arch are surmounted by eagles. Topping all is a quadriga with a winged "Victory," the most appropriate subject for the crowning feature of the arch. It is by the society's president, J. Q. A. Ward. There are also reliefs flanking the arch and on the sides representing the "Progress of Civilization" by J. Gellert, and the "Protection of our Industries" by W. Couper. Eight portraits of admirals are added as an enrichment to the spandrels of the smaller arches on the Twenty-fourth Street penetration. The upper end of the colonnade has two large groups also.

The arch is approached from the south by six double trophy columns arranged in pairs, three on either side, and the columns on Twenty-third Street and Twenty-fifth Street being reinforced by an extra column on either side, thus repeating the same effect of two columns when seen from the north or south. The first or south pair has groups of statuary by F. W. Ruckstuhl representing "The Army," and George E. Bissell "The Navy."

While the arch has been built for a naval celebration, the co-operation of the army in naval victories is thus fittingly suggested. These groups are among the finest creations of the sculptors, and rival the four principal groups on the arch itself. The columns forming the boundaries of the two plazas constitute a prolongation of the arch, for they are placed in line with its eastern and western ends and their base lines are identical with those of the arch, to which also they correspond in measurement. The columns between the entrances to the plazas and the arch have at each group of two a single figure of "Victory," by Herbert Adams. The beauty and distinction of this figure repeated on the decorative scheme in this manner is remarkably effective and pleases the eye by the good proportion of the figures and their environment. Each "Victory" holds aloft a tablet upon which in gold letters is inscribed the name of one of the ships in Admiral Dewey's squadron. There were seven ships, and as there are eight figures, the name of the "Olympia" is emblazoned twice. It appears in each court of honor.

At either end of the attic on both fronts are the dates 1775 and 1899. If it be asked why 1775 is placed there instead of 1776, the year of the Declaration of Independence, the answer is found in the fact that under the Continental Congress we had a small navy, and its establishment thus precedes the date of the nation's birth. In the two large central panels of the attic are inscriptions in Roman capitals. On the south front the inscription reads:

TO THE GLORY OF THE AMERICAN NAVY AND IN GREETING TO OUR ADMIRAL. A GRATEFUL CITY RELYING ON THEIR VALOR HAS BUILT THIS ARCH MDCCCXCIX.

On the north front is the inscription:

TO ADMIRAL GEORGE DEWEY, GREETING. WELCOME, HONOR. FROM THE PEOPLE OF NEW YORK, SEPTEMBER 30, MDCCCXCIX.

In the four corners of each panel is a five-pointed star. The other sculptural features of the attic are the eagle surmounting the keystone, modeled by A. P. Proctor, and symbolical ornaments of various kinds, such as wreaths and borders of oak and laurel. On the eastern end is the single word

MANILA.

and on the western end

SANTIAGO.

THE MANUFACTURE OF DONGOLA.

FOR the manufacture of this variety of leather green salted hides are, perhaps, the best, but dry hides may be used successfully. Great care is necessary in the "beam house." The hides must be thoroughly softened and properly handled. A brief liming is most successful, satisfactory results being obtained with 150 pounds of lime and 15 pounds of sodium sulphide to every 1,000 pounds weight of dry hides. After the usual fleshing, unhairing, washing, and bating, the hides are then washed. They are now "pickled" in a preservative made as follows: 500 gallons of water, 400 pounds of salt, and 35 pounds of sulphuric acid. This is thoroughly stirred until the salt has dissolved. The skins are then put in and occasionally handled and left for from four to five hours. They are next placed in a gambier liquor of about 6° Bk.* [Barkometer], to which 10 pounds of alum and two-thirds this quantity salt have been previously added to every 100 gallons of the liquor. The skins are left in this for three days, the liquor being strengthened each day. They are then split or shaved. They now go into a second liquor without alum or salt, the strength of which is judged by the effect upon the pelt. The usual strength is from 18° to 20° Bk., the goods remaining there for about three days. They are next drained and treated with a liquor consisting of 3 gallons of neat's foot oil to every 100 pounds of leather and slowly dried. The leather is then damped for "stuffing," for every 100 pounds of dried leather 5 pounds of French dégras, 3 pounds of cod oil, 3 pounds of neat's foot oil, and 2 pounds of paraffin oil being used. The stuffing oil is heated to between 80° and 90° C., the skins are turned in this for about twenty minutes, a small quantity of warm water is added, and they are then taken out and blacked, dried, and damped back for staking on the flesh side. They are finally ironed, if finished "in the dull." If bright finishes are desired, they should be seasoned and glazed. A good dull finish can be obtained by using the following preparation: In 2 quarts of logwood 2 ounces of gelatin are dissolved, ½ ounce of brown glue, 1 pint of vinegar, ½ ounce of glycerin, and ½ ounce of potassium bichromate. For a seasoning preparation in bright finish boil ½ pound linseed oil in 6 quarts of water, and of this take ½ pint and mix it with ½ gallon of blood, 1 quart of sweet milk, 1 pound of strong logwood, and ½ ounce nigrosine black. After application, hang in warm room and then glaze. The goods are finally finished with equal parts of neat's foot oil and olive oil.—Leather Trades Review.

* 6° Bk. = 1·006 sp. gr.; 60° Bk. = 1·060 sp. gr., and so on.

ACETYLENE FOR LANTERN AND ENLARGING.*

THE various kinds of lighting hitherto employed in enlarging and projections are in a decreasing order: electricity, oxygen mixed with gas, ether, or petroleum, gas alone, petroleum. In permanent installations a light is employed, in the absence of electricity, with oxygen as base. Oxygen is somewhat expensive, and, besides, requires a rather complicated apparatus, in consequence of which it is rarely employed by the amateur photographer, who, not having to illuminate big screens, usually adopts petroleum or gas. Certainly this light does not give him perfect satisfaction, but as there is nothing better he does not complain.

Like most amateurs, I had utilized coal-gas, but owing to several accidents I determined to change my system of lighting, and made some experiments with acetylene. For such experiments it is well, first, to investigate the degree of safety of the luminous sources placed in competition, and we have all the elements of comparison.

We know that petroleum, both in the state of lamp oil and of spirit, has caused and causes daily accidents which are often fatal, due, it is true, as much to the carelessness of consumers as to the dangerous character of this mineral oil. The misdeeds of coal-gas are so common that we need not mention them. The oxy-hydrogen, oxy-calcium, and oxy-ether lights all require great precautions. Everything considered, acetylene presents fewer chances of explosion than some of the enumerated systems of lighting, and it is not more dangerous than the remainder.

For example, the admixture of oxygen and hydrogen, which gives the brilliant and hot Drummond light, demands great care. Explosions of oil cans caused by carrying a light in their vicinity occur daily, as with coal-gas, so that comment is needless. Certainly acetylene is not free from these dangerous characteristics, but it reveals its untimely presence by a peculiar odor which warns of danger. Thus the new gas gives a sufficient number of guarantees to justify its admission into the photographer's studio.

If from the point of view of safety acetylene does not leave the other styles of lighting far behind, such is not so as regards quality and intensity of flame. With coal-gas all the rays of light are not utilized; the flame almost reaches the top of the glass protecting it, and we know that in a magic lantern the only useful light is that near the axis of the lenses. It is for this reason that one seeks before all else a powerful source of light with the smallest possible area. Acetylene beneficially fulfills this important condition.

For projection, a row of five burners can be employed, giving 150 liters of acetylene per hour, which is equivalent to a minimum of 20 carcels. The burners are situated one behind the other, like the multiple burners of the petroleum lamp. Owing to this arrangement, the flame is not high, all the light being concentrated at a slight distance around the optical axis. For requirements of an amateur lanternist, a row of three burners, 30 liters each, amply suffices. With the 12 carcels thus obtained, a sufficient light can be projected over a circle of 1 meter in diameter. The pictures are brilliantly illuminated. Their dimensions could be enlarged, but it is sufficient if we consider that the amateur will have a limited number of spectators, and that the ordinary dimensions of our rooms hardly admit of having the necessary retreat to cover a larger surface.

On the other hand, the three-burner row gives a luminous power which, when enlarging, allows of considerable shortening of the time of exposure. Even failures are to be feared unless somewhat dense negatives are employed. With a five-burner row, exposure would be too much curtailed, and results would not be good on account of the very rapid printing of the sensitized surface.

It being granted that we seek before all else a great luminous power during a relatively short time, no other apparatus seems so fitted for this style of work; besides, management is most simple, and when full there is no fear of a dangerous amount of gas, provided, of course, the operator is prudent. A point not to be neglected is the cheapness of this valuable apparatus, which will contain 750 grammes of carbide, producing 225 liters of acetylene, which represents more than two hours' burning for three burners. In fact, with the lantern, and particularly in enlarging, the time of work is little more than an hour, and it is not necessary to completely fill the metal basket with carbide.

In addition to better light, expenses are less with acetylene. Certainly oxy-calcium, oxy-hydrogen, oxy-ether, and electric lights are more powerful than acetylene, but they are very expensive. On the other hand, it is useless to make a comparison with petroleum, which gives a relatively feeble light of dubious quality. Comparison is only practical and interesting between acetylene and coal-gas. To obtain the 20 carcels mentioned above—obtained by the horary combustion of 150 liters of acetylene—a minimum of 2,000 liters of coal-gas have to be consumed. The 150 liters of acetylene gas are obtained with 500 grammes of calcium carbide at a cost of 65 centimes per kilogramme—i. e., 32½ centimes. The average value of 2 meters of coal-gas is 60 centimes; whence an economy of 27½ centimes per lighting hour.

To demonstrate the superiority of acetylene, we (Le Journal de l'Acetylene) must mention the enormous heat which the 2 meters of gas would give required for the carcels in the narrow limits of a magic lantern. We could find other arguments, make other comparisons, to the advantage of acetylene. Amateur photographers, without doubt, will wish to ascertain by experiments that the new easily-made gas is more economic and just as safe as its predecessors. Once convinced of this, lanternists will have no other light than this, the discovery of which should be regarded as a god-send for the art of photography.

* From The Optical Magic Lantern Journal and Photographic Enlarger.

"THE ARMY," BY F. W. RUCKSTUHL.

"THE NAVY," BY G. E. BISSELL.

[Continued from Supplement, No. 1240, page 19875.]

THE WORKS OF THE DIAMOND MATCH COMPANY, LIMITED.

Other machines make the outside covers of boxes from the strip. The strip is first of all scored in the direction of its length in four places, where bends will come, and then glued in one place in a continuous line by means of a revolving wheel, of which the bottom side dips in melted glue. It is then led forward through a system of rolls, which first of all bend and then double it, and form a sort of continuous tube of cardboard, the glued strip holding the two edges together. This "tube" of cardboard twice traverses the length of the machine, which is some 12 feet long, being led over wheels. This long travel has three purposes: (1) To let the glue dry; (2) to allow the machine to turn the tube over, so as to get the join in a suitable place for future operations; and (3) to allow the completed cover to be easily opened when the operation of putting the boxes in the covers is performed. The tube then passes between two printing rolls, which print any required design, first on one face and then on the other face, with one of the edges. Proper lengths of tube are then automatically cut off, thus forming the box covers; and the last process is to bring the edge of each box cover against a wheel dipping in melted glue, and then to throw white sand against the glue while it is still wet. This is done by means of a sort of revolving toothed wheel, which works in a box kept supplied with sand from a hopper. There are six machines of this type, of varying sizes, and they turn out from 300 to 640 covers per minute, according to size. They can be adjusted to take any requisite size of card. Our illustration, Fig. 5, shows one of the largest sizes.

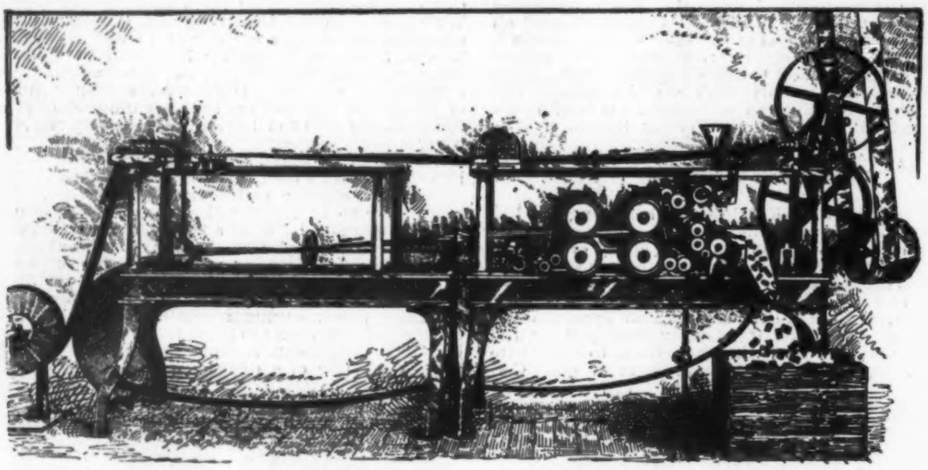


Fig. 5.—MACHINE FOR MAKING STRAWBOARD BOX COVERS.

In this room also are the machines for making wood chip outside covers for boxes, one of which is shown in our illustration, Fig. 6. The strips of wood, the production of which will be detailed hereafter, after being cut to the proper size, are put like packs of cards into a vertical holder; a reciprocating lever then removes the bottom strip of the pack and carries it forward, when it is caught by one of four formers placed at an angle of 90° fron each other on a revolving spider. By an ingenious series of slides and levers brought into action by the revolution of the spider the strip is bent into shape, and when thus bent into shape it is bound round by a label, which has been caught up from a number of labels placed face downward, also like a pack of cards, in a holder which can move up and down, and by doing so press the top label against a revolving leather band, which continuously passes beneath a hopper containing paste. The label adheres to the leather band, and is carried forward, and at the proper time two claws catch hold of it, draw it under the strip of wood and bind it round it, thus producing a box cover or "shuck," as it is technically called. When completed, the cover is automatically removed from its "former," delivered into a shoot and thence to a crate at the side of the machine. This type of machine turns out from forty to seventy covers in a minute, according to size, and there are twenty-two machines of various sizes at work.

On this floor also there is a fitting and repairing shop, power-worked. Here all repairs and renewals to machinery etc., are carried out, and the knives, dies, cutters, etc., are sharpened. The machinery consists of lathes, drilling machines, planing machines, shaping and milling machines, etc., and it is a very useful adjunct to a factory of this kind. In the north wing, on the third floor, there are further match-making machines of similar type to those on the top floor, only, owing to the breadth of the building, they cannot be so long as these, and hence the band is made to revolve slower so as to give the matches time to dry. Of course, this means a slightly less output. This department may almost be termed the mixed matches department, for a number of different kinds are made here. There are in all seven machines at work. Two are "square-stick" machines, two are "wood-vesta" machines, and two are of the ordinary type, called "grooved-stick" machines.

In the "square-stick" machine the sticks are not cut in the machine, but are supplied to it ready cut, and are put automatically into the revolving band, and then the process is precisely the same as that already mentioned. In the "wood-vesta" machine there is only a difference in the cutters. The sticks of the "wood-vesta" matches resemble those of wax vestas, being small and round.

In this department safety matches are also manufactured, the process being precisely similar to that used for ordinary phosphorus matches, saving, of course, that the composition used is not the same.

In the south wing on the third floor there are several ordinary "grooved-stick" machines at work, and eventually there will be a total of six. At the far end of this room there is also the chemical department where the "composition" for the match tips is manufactured. The machinery here consists of four mills for grinding and five "mixers." The mills are made with two cast iron plates revolving eccentrically to one another, between which the substance to be ground finds its way. The "mixers" are caldrons in which revolve paddles. The caldrons are fitted with removable covers with chimneys, which lead into the open air and take away any noxious fumes which may arise during the course of manufacture.

On the second floor, in the south wing, the "paper" or "book" matches are manufactured. The matches are made of cardboard, which is put into a machine, which, first of all, prints some letterpress on them, and then cuts the matches by punching the cardboard into the form of a comb, a portion equal to about one-quarter of the breadth of the slip being left unpunched so as to form the back of the comb. The card is then cut automatically into proper lengths.

The slips thus cut off are carried away from the machine by revolving bands, and are put by hand into frames composed of a number of strips of wood with holes at each end, threaded together on bolts by which they can be gripped tightly by means of fly nuts. The result is that frames are made some 16 inches square, from which the slit cardboard sticks up like the bristles of a brush. These frames are then put in racks one above the other, which racks can be wheeled about. The next process is to dip the cardboard points in paraffin, which is done after the cardboard ends have for some time been held on a heated plate. When the paraffin is dry the frames are stood, cardboard ends downward, on a steam-heated table, on which is a layer of "composition," carefully arranged at the right depth. This puts on the heads—safety heads in this instance. When the heads are dry, the strips are cut up into smaller portions and made up into books by having the backs of the combs wired together inside a cardboard cover, the strip of striking material being put on afterward by means of a revolving wheel, over which the books are made to travel. Saving the first operation, these matches are at present all made by hand labor, though it is proposed to eventually do everything by machinery.

The second floor of the main building simply contains "lumber," i. e., the wood used in the manufacture of the matches.

The wax-vesta matches are made in the north wing of the second floor. The worsted threads from which the tapers are made are drawn through a bath of heated paraffin wax and then through a die containing a number of holes, and the completed tapers are wound on big drums. The machines for manufacturing the matches are very similar to those for the ordinary matches. The tapers are fed in, and cut and placed in holes in a revolving band. These holes are formed half by a groove in the metal of the band, and half by a bent spring, which embraces the vesta and holds it in place. This method is used in preference to the simple hole, as in the case of the wood matches, because by its use the ends of the vestas are not damaged. There are three wax-vesta machines on this floor. There is a very handy and simple means by which all matches, which are not delivered into their boxes in the machine, or which have got "mixed," i. e., the heads not all one way, can be made to go into divisions on a board with their heads pointing the right way. The board is manipulated by a factory hand, who places a handful of matches on it, and by gently raising it to an angle and shaking it, the heads of the matches all point downward, and, by canting the board, can be made to go into any desired division. Each division holds a boxful, and as soon as the divisions are filled, the matches are taken out and put into boxes. One of the vesta machines only delivers the matches into wooden trays; they are then taken and put into boxes by hand.

In the south wing, on the first floor, is the "peeling" room, and here the thin strips of wood from which the boxes and covers are, as before described, made, are manufactured. A log of wood, Russian spruce or Baltic aspen, cut to a requisite length, is put into a lathe of special form, and a long knife advanced to meet it as it revolves. The knife is placed at such an angle that it cuts or peels off a very thin continuous strip of wood, which then passes by a series of knives arranged to cut it into strips of the required breadth, and also to score it in the places where, in the making of boxes, it will be bent. This is done in a very accurate way, the whole machine being automatic when once set, saving that the resulting cutting has to be led away by hand from the machine as it is produced. There are four lathes or "peelers," and there is a useful grinding machine by which the knives are ground automatically by means of an emery wheel with one setting. There are two "choppers" in this department also which cut the strip into the required sizes. The machine calls for no special mention. In this department, too, is carried on the manufacture of boxes for the packing and sending off of matches, though, in many instances, the boxes in which the "lumber" is brought from abroad are used for this purpose. The crates also for holding the various boxes, etc., during the progress of their manufacture, are here made and covered with wire netting. There is also a disappearing circular saw for cutting up the logs from which the strips are made. This saw can be made to descend completely below the floor level when not in use, thus minimizing the chance of accidents, which might be serious, as, owing to the weight of the logs, it is not convenient to lift them on to a table, so that they are cut as they lie on the floor, where they can be clamped in any required position on an adjustable bed.

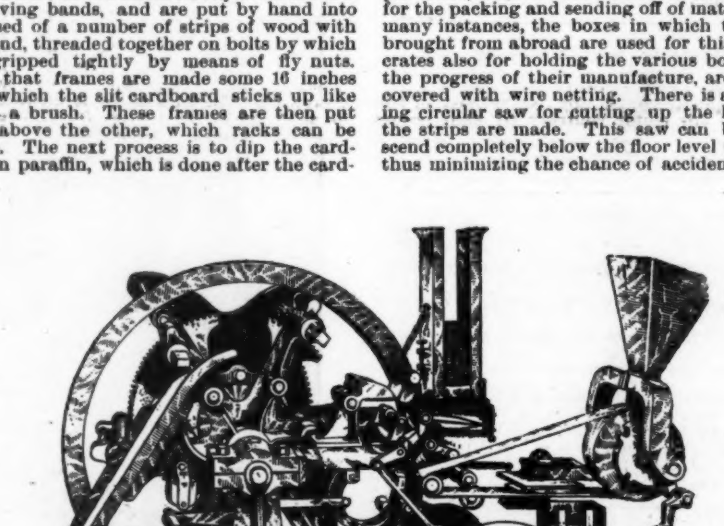


Fig. 6.—MACHINE FOR MAKING WOOD CHIP BOX COVERS.

On the first floor of the main building is what is called the shipping floor, and here the finished goods are stored, waiting dispatch. The offices, too, form part of the main building at this level. The north wing is simply used as a store. The basement of the main building is used as a general store, but it also contains the main line of shafting. This is driven by

belts from the engines, and any portion of the building can be thrown in or out of work by means of friction clutches.

The basement, north wing, contains what is certainly a feature of the factory, namely, a kitchen and cloak-room. Here, as the workpeople come in, they have to deposit their hats and cloaks, and also any food they may have brought in with them, so that this latter may not in any way come into contact with the chemicals used in the manufacture of the matches. There is also a number of sinks, with hot and cold water laid on, and it is imperative that the hands should be well washed before meals. In addition to the food brought in, the employes are provided free of charge with a bowl of soup or milk and rice. This seems to be greatly appreciated, nearly all the work-people partaking of it.

Besides being used to heat the air delivered from the fans, the exhaust steam from the engines is also used for the following purposes: Melting the paraffin wax for the match machines, heating the "composition" troughs, heating the glue pots on all machines using glue, heating the water for the washing sinks, heating the caldrons for the chemicals, heating the tanks containing the wax with which the vestas are made, heating the tables used in the manufacture of paper matches, and for other minor purposes.

There are two 30-cwt. lifts worked by straight and crossed belts off counter-shafting. These belts actuate worm gearing which turns a drum round which is wound the suspending rope. These lifts are of large size, and are provided with safety dogs, which would arrest the fall of the cages should the ropes break.

The whole of the building is lit by the electric light, and the wiring is all done on the surface, the cables being carried in porcelain cleats. Most of the lighting is done simply by flexible pendants, the lights being carried in switchholders. There are said to be four thousand lights about the buildings—all incandescent.

SPEED-CHANGING GEARS FOR MOTOCYCLES AND PHAETONS.

BETWEEN the costly and complicated gasoline carriage and the tricycle, the mechanism of which is reduced to its simplest form, there is room for an intermediate type—the phaeton—innumerable specimens of which were shown at the recent exposition organized by the Automobile Club of France.

The majority of these phaetons are merely transformations of the now well-known De Dion-Bouton tricycle. The evolution of this motocycle, which has been raised from 1¼ to 1¾ horse power, has been followed by us in these pages. But this transformation of the motocycle into a phaeton for two, and even for three persons, has, notwithstanding the increase in power of the motor, been brought about only by changes of speed. We will describe several speed-changing mechanisms after first showing the necessity for their use with the gasoline motor.

The power of a gasoline motor, as is well known, is proportional to the mean couple exerted by the piston upon the crank pin and to the angular velocity of the motor. But in this motor, contrary to what occurs with an electric motor, the mean couple is sensibly constant, and the power varies in inverse ratio to the angular velocity.

In order to obtain the best result possible from a gasoline motor, the ratio of the speed of the vehicle to that of the motor should be changed without varying the speed of the latter, which should remain constant and preserve its normal maximum value.

This is an ideal that has not as yet been obtained in automobile carriages, but we already possess a few approaches toward a solution, and these we shall now describe. Meanwhile, manufacturers are content to adopt three or four different speeds for carriages and but two for tricycles and phaetons. Following are the mechanisms that permit of quickly changing from one speed to another while the carriage is in motion:

The Couget Speed-Changing Device.—The inventor has very improperly given to this arrangement the name of "multiplier of force." In fact, the public, generally confounding force and power, is led to attribute to the apparatus the property of increasing the power, while its function is to change the ratio of the angular velocities of the motor and vehicle.

M. Couget's apparatus (Fig. 1) consists of a system of gear wheels interposed between the shaft of the motor and that of the differential gear. The entire mechanism is inclosed in an aluminum casing (Fig. 1, No. 1), which protects it against dust and supports the axes of the gear wheels.

In the normal position that corresponds to a high speed, the shaft of the motor (Fig. 1, No. 2) actuates the wheel, *E*, of the differential gear through the intermedium of the pinion, *A*, which meshes with the toothed wheel, *B*. For this high speed, the intermediate pinion, *D*, is not in gear.

In the position corresponding to the low speed (which is that represented in Fig. 1, No. 3), the pinion, *A*, is no longer in gear, and it is the pinion, *D*, that actuates the differential gearing, *E*, the former pinion receiving its motion through the pinion, *C*.

In Fig. 1, No. 1, will be seen the lever that permits of shifting the pinions, *A* and *D*, and of making them engage alternately according to the speed to be obtained. In the variation represented in No. 3 of the same figure, identical results are obtained by sliding the wheel, *B*, upon its axis; but the solution appears to us less satisfactory.

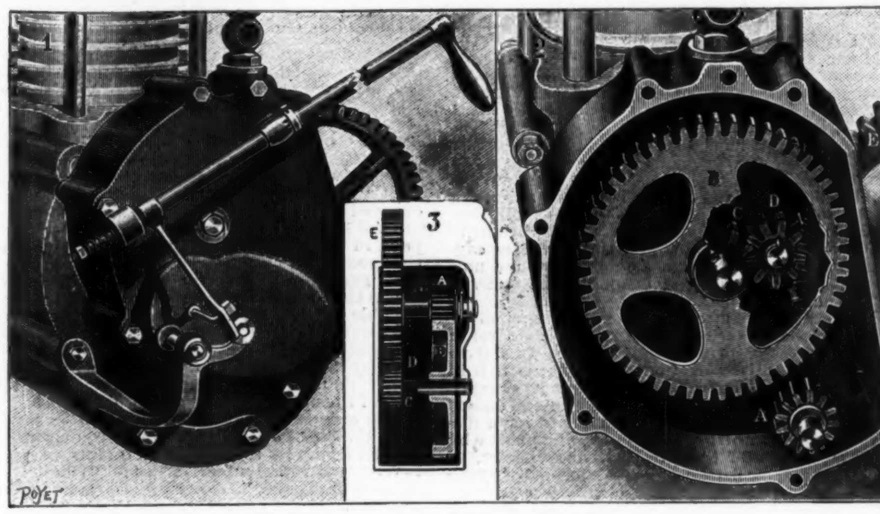


FIG. 1.—COUGET SYSTEM OF CHANGE OF SPEED.

The gearings are calculated so as to give normally a reduction in the ratio of 1 to 4; but such ratio may be varied at will.

The Didier Speed-Changing Device.—This arrangement, constructed by MM. Guyenet & Balway, and designed more especially for automobile tricycles, presents the peculiarity that the gearings are always engaged with each other, the changes being made through strong, notched clutches with strong and sure notches. The arrangement shown in Fig. 3 consists of five gear wheels and a double clutch placed in a frame. The two pinions, *BB'*, mesh directly with the toothed wheel of the tricycle and remain always engaged therewith. The pinion, *B*, is mounted loosely upon its shaft, while the pinion, *B'*, is fastened to its own shaft and revolves with it. To the right of these two pinions there are three others, of which the smallest, *B'*, turning loose upon its shaft, actuates the pinion, *B''*, through the intermedium of the loose pinion, *C*. Two clutches operated by a rocking lever permit of making the proper connections between these different parts and thus effecting the change of speed.

In the position represented in the figure, which corresponds to a high speed, the clutch, *A'*, makes the shaft of the motor and the pinion, *B*, interdependent, and the latter directly actuates the differential gearing, while the pinion, *B'*, remains loose upon its axis, the clutch, *A*, not being engaged.

In order to change from a high to a low speed, it suffices to cause the two clutches to slide upon their axes. The upper clutch, *A*, then renders the pinion, *B'*, and upper axis interdependent, while the clutch, *A'*, renders the pinion, *B*, loose and accelerates the pinion, *B'*. Motion to the axis of the differential gearing is then transmitted at a reduced speed, through the intermedium of the gear wheels, *B'*, *C*, *B''*, and *B'*. By changing the number of teeth of the pinions, *B*, *C*, *B''*, and *B'*, it is possible at will to modify the ratio of reduction and sacrifice the speed upon the ascent of heavy grades or in propelling weightier phaetons.

While running at a high speed, the gear wheels, *B'*, *C*, and *B'*, do not work. When the two clutches are in an intermediate position, everything is thrown out of gear and the motor can continue its operation without actuating the tricycle.

The Hugot Speed-Changing Device.—This apparatus, applied by M. Hugot to a phaeton that we have already described, is based upon the properties of the differential gear. Fig. 2, which shows the arrangement of it, will permit its operation to be understood.

The motor, *A*, actuates the wheels, of which the hubs are represented at *M* and *K*, through the intermedium of the pinion, *B*, and the spur wheel differential gearing, *C*, *D*, *E*, *F*. Two band brakes are placed at *G* and *H*. A coupling box at *J* permits of connecting the wheel, *K*, with the axle or allows it to turn on the latter.

When the transmission is running at normal speed (which is here low speed), the wheel, *K*, and its axle are coupled together and the transmission to the two wheels is effected through the intermedium of the differential gearing, as in all carriages with two driving wheels. Upon the differential gearing there is a pulley, *C*, that forms a casing, upon which acts a low speed brake not shown in the figure. In order to change from a low to a high speed, the brake, *G*, acting on the right-hand portion of the axle, is tightened and, at the same time, the wheel to the right is disconnected and allowed to turn free. Under such circumstances, the wheel, *M*, alone becomes the driving one and revolves with double velocity. The brake, *H*, then serves as a high speed one, and the brake, *C*, remains loosened. This system is remarkable for its simplicity, since it introduces no new gearing. All that is added is a brake and a coupling box. The only objection that can be made to it is that but a single driving wheel is employed just when the vehicle is at the highest speed; but, since such speed is never excessive in a phaeton, this inconvenience is only of secondary importance.

It will be seen from these examples, selected from among a score of others, that the problem of the change of speed for phaetons and tricycles is capable of being solved both simply and neatly. Experience alone will be able to make known to us the best systems to adopt.

For the above particulars and the figures we are indebted to La Nature.

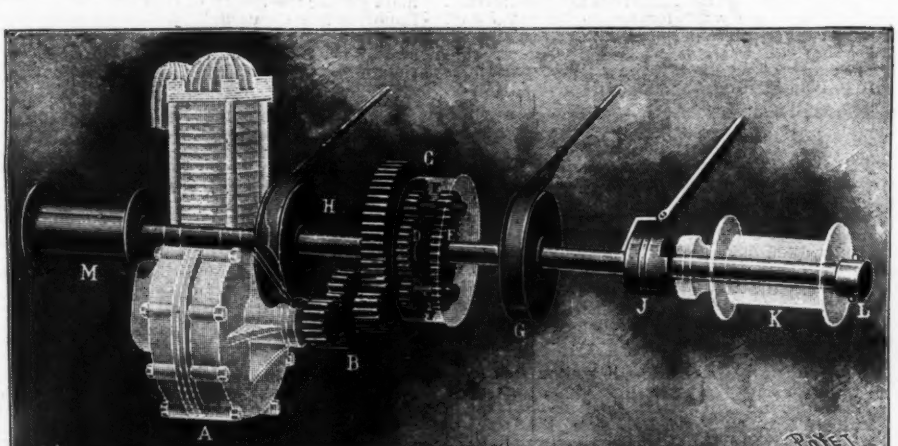


FIG. 2.—HUGOT SYSTEM OF CHANGE OF SPEED.

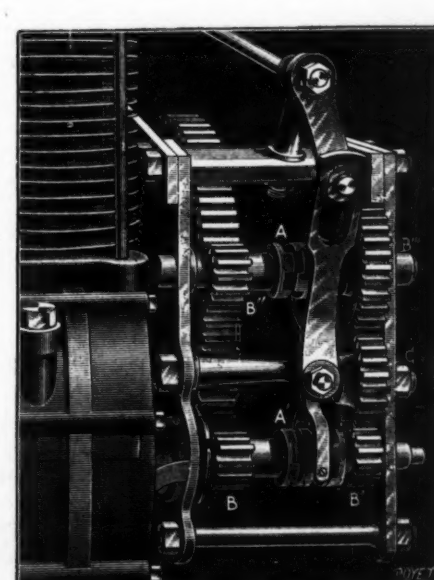


FIG. 3.—GUYENET & BALWAY SYSTEM OF CHANGE OF SPEED.

At St. Helens a glass manufactory has been started in which the old system of blowing is replaced by an automatic arrangement of moulds and blow-pipes worked by compressed air. It is said to be capable of turning out 5,000 tumblers a day, lamp chimneys at the rate of 3,000 and 4,000 per day, and larger articles in proportion. Under the old conditions a gang would turn out only about 400 tumblers a day, against 5,000 by the machine process.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

United States Capital in Venezuela.—I submit the following information relative to enterprises contemplated and under way in my district, in which United States capital is invested or solicited, says Consul L. T. Ellsworth, of Puerto Cabello.

The American Distilling Company, having a concession from the Venezuelan government covering the right to make whisky, etc., is calling the attention of capitalists in the United States to the enterprise. I am informed that the capital necessary for equipping distilleries in Caracas, Valencia, Puerto Cabello, and cities of equal importance, has been assured.

The concession for a railway between Puerto Cabello and San Filepe, through the State of Yaracuy, is in the hands of men who feel confident that they will interest capitalists of the United States. In fact, I am informed that the necessary capital is nearly all secured. If completed, this railway will tap virgin country, and bring to foreign markets the coffee, cocoa, hides, fruits, etc., of plantations that have been practically isolated.

The quarries of the Ganango Marble Company, of Puerto Cabello, are on the coast, about five miles east of Puerto Cabello. They produce a white marble, pronounced equal to the "Carrara," and beautiful colored marble. I understand that United States capital is invested herein, and that arrangements are now under way that will insure the opening of the quarries in a proper manner.

The Yaracuy River concession covers the navigation of the river of that name. The mouth of the river is about 12 miles west of Puerto Cabello. This river flows through a section of Venezuela that is rich in plantations of cacao, coffee, cattle, bananas, oranges, etc., and there is much valuable timber on its banks. It is navigable for river steamers and boats for a distance from its mouth of over 100 miles, and passes by many large cities and towns. Gen. José Ricart, of Caracas, owns the concession. I am informed that he is communicating with capitalists in the United States, with the object of putting on the river suitable steamers and boats to bring to Puerto Cabello the products of the plantations.

Quite recently, the Congress of Venezuela granted a concession of about 7,500 acres of land, located between the rivers La Palito and Capadare and bordering on the Gulf of Triste, about 6 miles west of Puerto Cabello, for banana-raising purposes. The owner of this concession intends to divide the land into six banana plantations. Included in the concession is the right to lay railways, put up telegraph and telephone lines, and ship to foreign ports direct, the Venezuelan government placing a customs officer on the train. I am informed that the owner of this concession is soliciting capital in the United States, and that his prospects for securing it are excellent.

The manager of the Tocuyo River Navigation Company, Mr. George Upton, of Warren, Ohio, has just returned from a business trip to the United States. This company has a concession to navigate the Tocuyo River, and to hold land along its banks. It has in this harbor two river steamers and a barge. Operations will doubtless be commenced shortly.

Count Emil Lewenhaupt, of Sweden, and Baron Eggers, of Denmark, are in Puerto Cabello, looking up the property of a syndicate of Europeans, which was purchased from the government of Venezuela over thirty years ago, but which has not been taken possession of by the purchasers. The deeds call for all of the land on one side of the Tocuyo River, which is several hundred miles in length and the mouth of which is on the north coast of Venezuela, at a point some 30 miles west of this port.

Vegetable Ivory in Ecuador.—In reply to inquiries by New York firms, Consul-General De Leon writes from Guayaquil, July 29, 1899:

There are four ports in Ecuador exporting tagua (vegetable ivory), as follows: Guayaquil, which sent out in 1897 about 3,700 metric tons; Manta, 3,000 metric tons; Esmeraldas, 2,900 metric tons; and Bahia de Caraquez, 1,900 metric tons; total, 11,500 metric tons.

Germany imports over two-thirds of this total, very cheap rates being obtained from the Kosmos Line to Hamburg via the Straits of Magellan. The United States ranks next in importance, importing about one-sixth of the total. The balance goes to France and England.

In the Guayaquil market, the harvest comes in during the rainy season. From February to July, while the rivers are swollen, great rafts of balsa (a very light wood) are loaded with the article and floated down from the forests on the head waters. Shortly after the rainy season has ended, the stock is all exported from this market, and no more can be had until the following harvest.

The prices in the Guayaquil market of 1899 are as follows, per 100 pounds:

Ivory nuts.	Sucres.	
Unpeeled	1·40 to 1·50=	$0.62 to $0.664
Peeled	2·40 to 2·60=	1.06 to 1.15
Free on board—		
Unsacked, add about	0·60=	0·265
Sacked, add about	0·75=	0·33

Merchants prefer to quote f. o. b. prices, but the following is the list of charges on tagua bought for account, per 100 pounds:

	Sucres.	Cents.
Landing	0·10	=4
Lighterage	0·04	=1·7
Storage	0·02	=0·85
Insurance, one-half of 1 per cent.		
Embarking bulk	0·10	=4
Exportation tax	0·17	=7·5
Commission, 4 per cent.		

If the tagua is sacked, the charges are, per 100 pounds:

	Sucres.	Cents.
Sacks	0·15	=6·6
Sacking	0·05	=2·2
Sack marking	0·005	=0·22
Embarking, sacked (6 centavos less than in bulk)	0·04	=1·7

Freight rates are as follows: To New York, via Panama, long ton, $16 gold; to New York, via Straits of Magellan, long ton, 35 s. ($8.52); to Hamburg, via Straits of Magellan, metric ton, 32·5 s. ($7.91); to Liverpool, via Straits of Magellan, long ton, 42 s. ($10.22).

The palm which bears this nut abounds in the forests of the Pacific slope of Ecuador, and is not extensively worked on account of the low prices which it commands. A good description of the tree as it exists here can be found in the Encyclopedia Britannica.

Interested parties may communicate with the following exporters in Ecuador: Messrs. Servat & Dumarest, Esmeraldas; Messrs. Alejandro Santos & Company, Bahia de Caraquez; Messrs. Norverto Osa & Company, Manta; Messrs. Martin Reinberg & Company, Guayaquil; Mr. J. S. Bruno, Guayaquil; Messrs. Lopez & Guzman, Guayaquil; and E. Pavia (agent, Flint, Eddy & Company), Guayaquil.

Trade Opportunities in Russia.—The Austrian consul in Tiflis complains about the very limited amount of iron exported from his country to the Caucasus, says United States Consul J. C. Monaghan, of Chemnitz. He pictures the progress being made by the Germans. Among other things to which he calls attention is the competition between the Caucasus and Siberia. The Siberian works produce an iron that is very popular in the Caucasus, but the terms of delivery are somewhat oppressive. Orders must be given a year ahead, with at least 10 copecks per pood (5·15 cents per 36 pounds) paid in advance. Even then, no guarantee is given that goods will be delivered on time. In Siberia, the work goes on with never an hour's rest the year round. When the ice melts in the rivers, as large quantities as possible are delivered. As soon as the deliveries begin, buyers must have remittances ready; and it often happens that the greater part of the payment must be sent by wire. Inasmuch as the demand is always larger than the Siberian output, the works in that part of the empire fix prices and conditions. In spite of the enormous import duties—50 to 60 copecks per pood (25·7 to 35·5 cents per 36 pounds) on some kinds—foreign countries send in large quantities. Germany is very well represented. Baku buys half its supply outside of Russia, and of this, Germany supplies 20 per cent. Most of the German iron exported thither is for reservoirs, boilers, and what is known here as façon iron. There is a big opening for iron girders, beams, etc. Hitherto, Belgium has had the most of this trade, but is losing it on account of the inferior qualities supplied. The same is true of band iron. There is also a large demand for what are known in Germany as steel paggeln, for boring chisels. They are wanted in lengths of 39 to 58·5 inches; width, 5·85 to 18·5 inches; thickness, 3·12 to 5·85 inches. The production of these bars, weighing, as they do, 1,300 to 2,600 pounds, is very difficult. Recently, Krupp began to sell them for $119 a ton. In the middle-grade goods, Germany controls the market. In spite of this empire's splendid equipment for producing wire ropes, it has not sold many, if any, to Russia; England, Belgium, and Austria-Hungary have controlled this line. This field is still open to good articles. The wire rope of Russian production, in many lines, fails to give the same satisfaction as foreign goods. Roof tin has a good chance. Great quantities are in demand.

In spite of Russia's rapid rise in industries, it will be a long time before she will be able to supply more than a very small percentage of her vast needs. Even the enormous duties cannot keep foreign goods out of her markets. Mariopol, on the Sea of Azof, is an excellent field in which to sell machines and parts of machines. Here, too, is a good opening for wire ropes, for machine couplers for wire ropes, for shovels, furnace forks, mining machinery, etc. English goods are falling off because they are too dear. Germany, favored by cheap transportation expenses, supplies a large part of the present demand. Enterprising concerns that go early to Mariopol, in the heart of the mining country, are sure to reap a rich reward. Here, too, is a most excellent opportunity for manufacturers of agricultural implements. Harvesting machines will sell in the Crimea, notably in Kertsch.

The opportunity offered in Russia is one of the very best in the world. All we have to do is to adapt ourselves to the requirements of the Russian people—not a very hard task—and a very large share of her foreign trade will fall into our hands. The conditions prevailing in the vast empire could not be more favorable to our manufactures. No nation is so well equipped as we are to supply Russia with the very best weapons with which to work out her industrial and commercial destiny. There are vast forests to be cut away, marshes to be drained, mines of all kinds to be opened, canals to be dug, waste lands to be reclaimed, railroads and mills of all kinds to be built, etc. Who is going to build and supply?

Opportunities in South Africa.—I submit the inquiry, says U. S. Consul-General Stowe, of Cape Town, Why does not the United States, with her resources, furnish this colony with certain commodities and preparations the ingredients and bases of which are produced more largely in the United States than elsewhere? As an example, take certain exports from the United Kingdom to this colony alone in 1898. In preserved meats the United Kingdom sent 846,034 pounds in a total importation of 3,676,848 pounds. Of course, of this one article, the United States furnishes the bulk, namely, 2,116,088 pounds; but is it not a fact that preserved meats, like preserved fish (salmon, for instance), are shipped from the United States in cans unlabeled, and English labels put on?

Of preserved fish, the United Kingdom furnished this colony 4,052,432 pounds, the total importation being 4,705,668 pounds. Of salted meats, the United Kingdom sent 2,414,370 pounds, against a total of 2,621,449 pounds. From this one can see what is done with the large number of hams and sides sent from the United States uncured to Great Britain and there cured.

Of soap, the imports from the United Kingdom were 12,989,781 pounds against a total importation of 13,292,343 pounds, and yet nearly all the soap stock—fats and the cotton-seed oil—are of American origin.

Typewriters to the value of £6,348 ($30,893) were sent from the United Kingdom, the total imports being £12,642 ($61,522), and yet I am informed that only one typewriter (an American invention) is manufactured in that kingdom. Why not sell the United States typewriters to Cape Colony direct?

Out of a total importation of plated silverware of £40,944 ($199,254), the United Kingdom sent £35,538 ($172,946), and yet the United States is called the great silver-producing and plate-ware manufacturing country.

The United Kingdom in 1898 sent 73,252 pounds of tobacco out of a total import into the colony of 136,536 pounds, 6,910,718 cigars out of a total import of 12,384,244, and 20,413,259 cigarettes out of a total import of 77,174,599—all made from North Carolina and Virginia leaf.

With the vast crops of apples raised in the United States, why should the United Kingdom send 64,535 gallons of vinegar out of a total importation of 65,533 gallons, while the United States sent none.

The United States is the greatest furniture manufacturer among the nations, yet furniture to the value of £267,044 ($1,299,570), out of a total importation of £367,875 ($1,789,964), was received here from the United Kingdom in 1898.

Is not the glue produced by the great packers of America worth exporting, and can it not be produced as cheaply as elsewhere? Yet the United Kingdom sent hither 126,474 pounds out of a total of 136,166 pounds.

Lead and zinc were received from the United Kingdom in 1898 as follows: Lead, 23,815 cwts., and zinc valued at £1,414 ($6,881), against a total of 27,715 cwts. of lead and £2,981 ($14,507) worth of zinc.

Candles to the amount of 3,116,677 pounds were received from the United Kingdom out of a total import of 3,488,880 pounds; yet the greater portion of the tallow, spermaceti, stearin and stearin wax, stearic acid, and paraffine wax entering into their manufacture must have been of American origin.

Bicycles to the value of £135,760 ($660,675) were received from England out of a total import of £174,650 ($849,934).

Golden sirup to the amount of 2,656,471 pounds out of a total import of 2,730,351 pounds was received from England, while the United States furnished only 5,141 pounds. The United Kingdom, to make the sirup, must import the sugar, etc.

Of cotton goods, the United Kingdom furnished £1,055,999 ($5,139,019) out of a total of £1,136,177 ($5,529,205); and yet the cotton came mainly from the United States.

Out of 6,073,060 pounds of potatoes, the United Kingdom sent 3,647,523 pounds. I am told that a large quantity of these were importations for seed, which has to be renewed in this colony every two years.

Admitting that much that is made and produced in the United States is sold through other countries to this colony and country, the question arises, Is the United States getting credit for exports to South Africa? In like manner it may well be asked, Does the United States get credit for the products which she imports from South Africa? The reasons for these conditions are many, but the one reason, perhaps, above all others is that Great Britain has the ships, the banking facilities, and the great merchants located in foreign countries.

Hog Meat in Singapore.—Consul-General Moseley writes from Singapore, July 19, 1899:

It seems that the attention of our large packers of bacon, hams, and lard should be directed to the high prices of the product of the hog in this market. Bacon retails at 45 cents silver (21·6 cents) a pound; ham, from 55 to 85 cents (26·4 to 40·8 cents) a pound; and lard at 45 cents (21·6 cents).

So far as I have been informed, there is no American bacon, ham, or lard for sale here. Singapore is a depot for a large territory, and I believe a good demand for the products of the American hog could be created here, if proper efforts were made by our packers.

Inquiry for Iron and Steel in Belgium.—Consul Le Bert, of Ghent, on August 15, 1899, writes:

Mr. M. D. Levison, No. 58 rue Van Eyck, of this city, desires names and addresses of manufacturers of pig iron, Thomas; hematite and manganesian (Spiegel); bar steel; blooms, Thomas and Bessemer.

He states that if prices are satisfactory, the transaction will be of considerable importance. Prices should be given c. i. f. at Antwerp, net cash.

Flour in Guatemala.—According to a government decree issued on August 11, 1899, which has been transmitted by Consul-General Beaupré under date of August 22, flour will be admitted free of duty into Guatemala during the month of October. The duty on flour imported into Guatemala, according to its tariff schedules, is 5½ centavos per kilogramme (2·2046 pounds) and 15 per cent. additional duty. Thirty per cent. of the duty is payable in gold and the balance in silver.

Belgian Demand for Refrigerators.—The following, dated August 24, 1899, has been received from Consul Le Bert, of Ghent:

The firm of Dutry-Colson, rue des Champs, of this city, requests names and addresses of manufacturers of refrigerators. This firm is thoroughly reliable and one of the largest in its line in Belgium. There is a good field here for American refrigerators.

Index to Advance Sheets of Consular Reports.

The Reports marked with an asterisk (*) will be published in the Scientific American Supplement. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

TRADE NOTES AND RECEIPTS.

Pomade for the Lips.—Lip-pomatum which is said to always retain a handsome red color and never to grow rancid is prepared as follows:

Paraffine	80·0
Vaseline	80·0
Anchusine	0·5
Bergamot oil	1·0
Lemon oil	1·0

—Neueste Erfindungen und Erfahrungen.

Embalming Composition.—J. W. Wagner employs a liquid composed as follows:

Cooking salt	500 grammes.
Alum	750 "
Arsenious acid	350 "
Zinc chloride	120 "
Mercuric chloride	90 "
Formaldehyde solution, 40 p. ct.	6,000 "
Water, up to	24,000 "

—Neueste Erfindungen und Erfahrungen.

Antiseptic Value of Essential Oils.—Peek has conducted experiments on the antiseptic value of the volatile oils with the following result:

Cassia oil acts antiseptically	1:2233
Cinnamon oil "	1:2100
Oil of cloves "	1:1028
Sassafras oil "	1:1000
Peppermint oil "	1:875
Cajeput oil "	1:120
Eucalyptus oil "	1:116

—Neueste Erfindungen und Erfahrungen.

Paraffining of floors has come into use in France for hospitals and schools, to render the floors resistive to infectious matters. According to Schweizer Schreinerzeitung, the cracks and joints of the parquet floor are filled up with a putty consisting of Spanish white, 540 parts; glue, 180 parts; siena, 150 parts; umber, 110 parts; and calcareous earth, 20 parts. After forty-eight hours apply the paraffine, which is previously dissolved in petroleum, or preferably employed in a boiling condition, in which case it will enter 4 millimeters into the floor. When solidification sets in, the superfluous paraffine is scratched off and an even, smooth surface of glossy color results, which withstands acids and alkalies.

The Seifensieder Zeitung gives the following receipts for the manufacture of sealing wax:

Finest Red Carmine Wax.—Turpentine, 40; American colophony, 60; best blood-colored shellac, 160; carmine vermilion, 100; heavy spar, 60; light spar, 40; tolu balsam, 20; oil of turpentine, 40.

Packing Wax.—I. Brown, medium quality: Turpentine, 40; American colophony, 460; shellac, 120; English red, 80; heavy spar, 560; light spar, 240; oil of turpentine, 40. II. Red, fine: Turpentine, 40; American colophony, 320; blond shellac, 200; German vermilion, 50; heavy spar, 400; light spar, 200; oil of turpentine, 40.

Bottle Wax.—I. White: Turpentine, 160; pale colophony, 600; metallic white, 160; heavy spar, 700. II. Red: Turpentine, 200; American colophony, 600; stearine, 100; vermilion, 60; heavy spar, 1,200. III. Silver, transparent: Turpentine, 100; Japanese wax, 100; pale colophony, 8,000; imitation leaf silver, 10.

Note on Rubber and Rubber Articles.—As regards the action of coal gas on rubber tubes, it has been observed that it is weakest on ordinary gray rubber, which withstands it the longest, and gives off no odor. Red rubber is more readily affected, and the black kind still more so.

To prevent rubber tubes from drying up and becoming brittle, they should be coated with a 3 per cent. aqueous solution of carbolic acid, which preserves them. If they have already turned stiff and brittle, they can be rendered soft and pliant again by being placed in ammonia which has been made liquid with double the amount of water.

In France rubber tubes are used as a core for casting pipes from cement and sand. In order to construct a connected pipe conduit in the ground, a groove is dug and a layer of cement mortar spread out. Upon this the rubber tube is laid, which is wrapped up in canvas and inflated. The remaining portion of the channel is then filled up with cement mortar, and as soon as it has set, the air is let out of the rubber hose and the latter is pulled out and used as before. In this manner 6-inch pipes have been produced from hydraulic lime and sand at the expense of about 1 mark (24 cents) per meter.

Artificial Rubber.—An elastic mass, similar to caoutchouc, from which rubber is made can be produced by combining sodium tungstate with certain organic substances. If tungstic acid or sodium tungstate is added to glue and then to hydrochloric acid, a tungstic glue is produced which, at 85° to 105° F., is so elastic that it may be drawn out into very thin fibers. By cooling, this mass becomes very firm and brittle. This product may be used for mordanting specially for aniline dyes. It was also employed for tanning leather, but turned with it as hard as stone, for which reason it has not entered greatly into use.

To rid rubber articles of their unpleasant odor, both sides are covered with a layer of animal charcoal and heated with it to 50° to 60° C.

To cover cloth with rubber, there are chiefly employed for dissolving the rubber, naphtha, alcohol and benzol. They are mixed with purified solid paraffine, and ground together.

Cement for Rubber.—Dissolve 1 lb. of pure rubber, in small pieces, in 4 gallons of rectified coal tar naphtha, and stir diligently. After 10 to 12 days, double the weight of this liquid of shellac is to be added. This mixture is heated in an iron vessel, having a discharge pipe at the bottom. When all is liquid it is poured on stone slabs and allowed to cool in the shape of plates. For use this cement is heated in an iron vessel and applied with a brush on the surfaces to be united.

Rubber boots and shoes are rendered water-proof by melting 4 parts of spermaceti and 1 part of rubber on a moderate fire, adding tallow or fat 10 parts, and lastly, 5 parts of copal varnish or amber varnish. This mixture is applied on the shoes with a brush. It should be stated that the rubber used for this purpose must be cut up very small and allowed 4 to 5 hours to dissolve.—Die Werkstatt.

MISCELLANEOUS NOTES.

The largest contract entered into in recent years for shipbuilding on the Great Lakes has just been signed. This contract will call for the construction of two steel steamers each with a load water line of 435 feet, beam 50 feet.

The exports of briquettes from Belgium in April amounted to 39,724 tons, as compared with 50,534 tons in April, 1898, and 44,810 tons in April, 1897. The aggregate exports in the first four months of this year were 167,289 tons, as compared with 165,139 tons in the corresponding period of 1898, and 158,379 tons in the corresponding period of 1897. In these latter totals the exports to France figured for 79,694 tons, 74,877 tons and 62,490 tons respectively.

According to a contemporary, the maximum spans possible for wires of different materials on a basis of a factor of safety of four is as follows: Cast steel wire, 3·42 miles; silicon bronze, 1·56 to 1 mile, depending on quality; wrought iron, 1·02 miles; and soft copper, 0·53 mile. These maximum spans, it is said, are independent of the cross-section of the wire, for although the weight of the wire increases with the cross-section, its strength increases in the same proportion. The spans given do not allow for wind pressure, snow or ice.

The largest German colliery concern, the Harpen Company, is on the eve of still further increasing its importance by acquiring the Courl Colliery, which realized a profit last year of 3·2 marks per ton, while the mean profit made by the Harpen pits did not exceed 2 marks 25 pf. per ton. In view of this addition to the property of the Harpen Company, the issue of 6,000 new shares of 1,000 marks each has been decided upon. That company will thus have 20 shafts in operation; and its apportionment figure for the present year has accordingly been raised by the Rhenish-Westphalian Coal Syndicate to 5,387,000 tons.—Engineering and Mining Journal.

Cast aluminum is about equal in strength to cast iron in tension, while under compression it is comparatively weak. With a purity of 99 per cent. the ultimate tensile strength of aluminum per square inch is, in castings, 18,000 lb.; in sheet, 24,000 lb. to 40,000 lb.; wire, 30,000 lb. to 55,000 lb.; and in bars, 28,000 lb. to 40,000 lb. The elastic limit of aluminum of this purity is, for castings, 8,500 lb.; sheet, 12,000 lb. to 25,000 lb.; wire, 16,000 lb. to 33,000 lb.; and bars, 14,000 lb. to 23,000 lb. per square inch. Taking tensile strain in relation to weight, pure aluminum is as strong as steel of 80,000 lb. per square inch.—The Engineer.

Discussing the outlook for olive oil, The Oil, Paint, and Drug Reporter says that the output of Spanish oil will not be up to the average, that the new crop in Italy will be very small and unworthy of consideration, and the Italians may have to buy in other markets for home consumption, but the Levant production will probably be normal. While the stocks in foreign markets are undoubtedly larger, especially in Messina, than at this time last year, the same cannot be said as to local supplies, the recent trouble with the appraiser's office in regard to the distinction between edible and manufacturing oil having tended to discourage the importation of the latter. It is also reasonable to assume that consumers' stocks are not very heavy, owing to the provisions that importers have been compelled to insist upon when making sales. It is interesting to observe in this connection that, should the foreign markets on olive oil for manufacturing purposes advance above the parity of 60 cents per gallon, the fact that such oil would then be dutiable at 40 cents per gallon would practically prohibit its importation into this country, unless soap makers and others were willing to pay the advanced figure, including duty.

After most exhaustive trials of the Babcock & Wilcox water tube boilers in Her Majesty's steamship "Sheldrake," the British Admiralty express themselves as highly pleased with the results. In an economy trial, 15 pounds of coal being burnt per square foot of grate per hour, the steam pressure at the boilers was 152·5 lb. per square inch, and an air pressure of 0·2 inch of water, the temperature of the feed water being 103°, and of the steam 366°. The power developed by the engines running at 242 revolutions per minute was 2,642 indicated horse power; the speed of ship attained 17·9 knots an hour, and the coal consumption 1·429 lb. per indicated horse power per hour, while a full power trial resulted as follows: Boiler pressure 150 lb., draught equal to ½ inch of water, feed water 110°, steam 366°; engines making 280 revolutions per minute, developed 4,050 indicated horse power, and a speed of 20·6 knots. Coal consumed 1·57 lb. per indicated horse power per hour. Heating surface 2·3 square feet per indicated horse power, and the indicated horse power per square foot of grate 16. Later, on a 1,000-mile run at 2,250 indicated horse power, the coal burned per indicated horse power per hour was 1·62 lb., 18¾ lb. being burnt per square foot of grate area.

Mr. Ransome, in his new book "Japan in Transition" (Harper Brothers), quotes the following case as illustrating the risk incurred in accepting the local inspection clause in connection with Japanese contracts. Mr. Ransome says: "I cannot do better than refer to the large contract that was given out for cast iron pipes for the Tokyo Waterworks. The contract in question amounted to about 16,000 tons of pipes and bends of all dimensions, from 4 feet in diameter downward. The order was divided between two English firms, and one Belgian. The Belgian house put in a very low figure, and received an order for 10,000 tons out of the 16,000. Of the 10,000 tons of Belgian pipes, only 2,700 were accepted, and of the English 4,000 out of the 6,000. The greatest sufferer by the above transaction is the Belgian contractor, who took the risk of inspection in Japan on his own shoulders, and now finds himself saddled with three-fourths of his goods after delivering them half-way round the world. The risk of the British pipes was taken by two firms of merchants in Japan, who supplied the goods in question, one being an English and the other a Japanese house. There is no doubt that, with the exception of a small percentage, the rejected pipes, whether or not they filled the specification to the letter, were perfectly good for the purpose."

SELECTED FORMULÆ.

Horticultural Receipts.—

DESTRUCTION OF MICE.

Lard	500	parts.
Salicylic acid	5	"
One onion.		
Suet	0·50	"
Barium carbonate	500	"
Solution of ammonia, acetate of copper or of verdigris	50	"

The onion is cut up fine and fried with the fats until dark brown. The salicylic acid is then added and the mixture strained and stirred until the fat nearly sets. The barium is next added, and, finally, the copper solution.

DESTRUCTION OF RATS.

1. Precipitated barium carbonate	100	grm.
Tartar emetic	1	"

Mixed with baked flour and glycerin in 2 grm boluses, which are fried brown in hot fat.

2. Gypsum	2	parts.
Oatmeal	750	"

Flavor with anise oil.

3. Plaster Paris and sugar, equal parts.

The mixture is spread on a plate and exposed near a vessel of water.

4. Crushed bitter almonds	60	parts.

Lard,
Fresh squill bulbs, equal parts.

MOTH AND CATERPILLAR LIME.

1. Venice turpentine	200	parts.
Resin	1,000	"
Turpentine	140	"
Tar	80	"
Lard	500	"
Rape oil	240	"
Tallow	200	"
2. Resin	50	parts.
Lard	40	"
Stearine oil	40	"
3. Resin	3	parts.
Rape oil	4	"
Lard	2	"
Soft soap	1	"
Wood tar	10	"
4. Resin	36	parts.
Rape oil	36	"
Venice turpentine	20	"
Wood tar	5	"
Turpentine	3	"

Paint the mixture, while warm, on strips of paper laid smoothly on the tree trunk about a yard above the ground. This should be done at the end of October or the beginning of November, to prevent the females of the winter moth from climbing trees.—American Druggist and Pharmaceutical Record.

Shampoo Mixtures.—

Soft soap	1 ounce.
Solution potassa	1 "
Alcohol	2 "
Perfume	q. s.
Water	q. s. ad 10 fluid ounces.

Water of ammonia	1 ounce.
Cologne water	1 "
Soft soap	4 drachms.
Alcohol	6 ounces.
Water	q. s. ad 20 fluid ounces.

Dissolve the soap in the spirit, add the rest of the ingredients, and filter.

SEA-FOAM SHAMPOO.

Ammonium carbonate	2 drachms.
Alcohol	2 ounces.
Glycerin	1 "
Rose water	1 pint.

BORATED SHAMPOO.

Potassium carbonate	1 ounce.
Borax	1 "
Water	2 pints.

EGG SHAMPOO.

Borax	2 ounces.
Glycerin	1 "
Rum	10 "
Bay rum	10 "
Whites of	2 eggs.

Incorporate the borax in fine powder with the glycerin; add the rum and bay rum gradually, with constant stirring. The previously well beaten whites of eggs are added lastly, and the whole thoroughly mixed.

DRY SHAMPOO.

Tincture of soap bark	4 drachms.
Sodium borate	4 "
Ammonium carbonate	4 "
Oil of bay	10 minims.
Alcohol	5 ounces.
Distilled water	15 "

Dissolve the salts in the water and add to the solution the alcohol in which is dissolved the oils.

SAPONACEOUS SHAMPOO.

Green soap	9 drachms.
Potassium carbonate	18 "
Alcohol	3 ounces.
Water	25 "

Dissolve the carbonate in the water and add the soap and alcohol.—Bulletin of Pharmacy.

Extract of Vanilla.—The formula is:

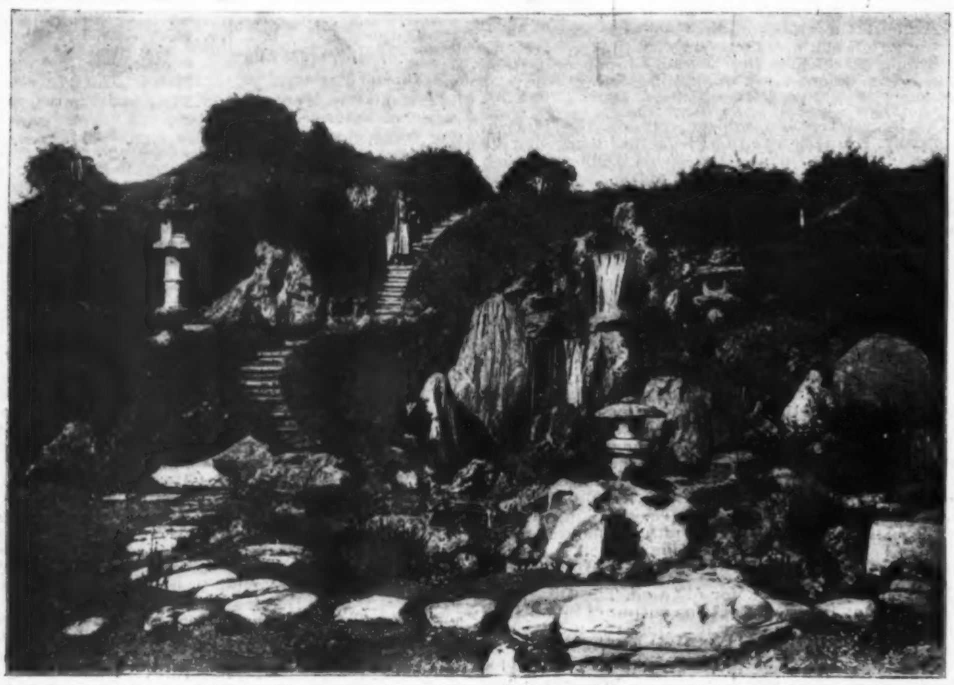
Vanilla beans, good quality	8 ounces.
Pumice stone, lump	1 "
Rock candy	8 "

Alcohol,
Water, of each a sufficiency.

Cut the beans to fine shreds and triturate well with the pumice stone and rock candy. Place the whole in a percolator and percolate with a menstruum composed of 9 parts of alcohol and 7 parts of water until the percolate passes through clear. Bring the bulk up to 1 gallon with the same menstruum and set aside to ripen.—American Druggist.

SCENES IN TOKIO.

OUR engravings, for which we are indebted to the Illustrated London News, give some views of Tokio. In few places have nature and art been combined so delightfully as in the Mikado's gardens at Tokio. Urns and statues are mingled with rocks which are left in position and combined with waterfalls and fountains under the intense sky of the East the effect is fascinating. The gardens are, of course, very quiet, and the hum from the busier quarters of new Tokio is quite distinct. The Japanese capital is increasing in business turmoil every day, as it is the natural outlet for all the northern part of the country. The Mikado's palace is built close to the "Shero" or ancient fortress in the oldest and quaintest part of the city, so that the noises are softened away and an Oriental peace seems to be everywhere. Our other view is in striking contrast, as it shows one of the Japanese fruit shops in the busy portion of the city. The fruit of Japan is much esteemed, not only by the natives, but by foreigners who live there or pass through the place. The fruit is cheap and is consumed by the natives in large quantities.



THE MIKADO'S GARDEN, TOKIO.

A JAPANESE FRUIT SHOP.

SCENES IN JAPAN.

PEAT IN ONTARIO.

THE most serious problem that confronts the Canadian people of the future is material for fuel, says United States Consul A. G. Seyfert, of Stratford. The gigantic lumber industries and the great annual forest fires have so denuded the timber area of Ontario that the people are thoroughly alarmed about the future fuel supply. Hard wood for fuel is now worth from $6 to $8 a cord and soft from $3 to $5, while coal, which is all imported from the United States, costs $6 a ton. The item of fuel is therefore one of the heaviest expenses to every housekeeper in this latitude of long and severe winters. An ordinary residence will consume not less than $100 worth of fuel in a year. It has been well known for years that there were extensive beds of peat bogs in Canada, and particularly in the Province of Ontario. An effort has been made during the past six months to utilize this product of nature. In Ireland, Wales, Holland, and Bavaria peat has long been the chief fuel used by the poor. The recent invention of machinery, by means of which vast areas of hitherto unused bogs can be converted into marketable peat, has opened up a new Canadian industry.

The origin of peat bogs is well understood. They occur in low situations or where some natural or artificial obstacle impedes the drainage. Abundant moisture favors the growth of a low order of plants, such as the Sphagnum mosses. This plant is noted for its absorption of water. Its structure is that of reservoirs in successive layers, which are kept filled by capillary attraction, even when the plant itself is above water level. The same properties of the moss tend also to its decay. It requires a constant supply of moisture, yet it is continually pumping up to the surface of its tufts the water in which it stands, thus promoting evaporation, while at the same time, by regularly decaying at the roots, it deposits the detritus which adds to the solid contents of the bog. This process goes on until the bog is raised above the level of the surface waters, when Sphagnum vegetation ceases.

The best authorities say that there are 100,000 acres of this undeveloped peat bog in Ontario, principally in the counties of Perth, Welland and Essex. The largest area lies in the county of Perth, 8 miles north of the city of Stratford, on the Grand Trunk Railroad that extends from Port Dover to Owen Sound. Here is a swamp of 40,000 acres with a depth of peat bog that varies from a foot to 20 feet. About a year ago the Canadian Peat Fuel Company was organized, and early in the summer active operations to put the fuel upon the market began.

The process of manufacturing it is as follows: The peat is cut and air dried, after which it is pulverized by being passed through a picker, and automatically deposited in a hopper which feeds a steel tube, about 2 inches in diameter and 15 inches long. The pulverized peat is forced through this tube by pressure, and formed into cylindrical blocks 3 inches in length and almost equal in density to anthracite coal. The fuel is non-friable and weatherproof by reason of its solidity and the extreme glaze imparted to it by frictional contact with forming dies. The inherent moisture of the peat is reduced to 12 per cent. of the moss. In weight, it compares with coal as follows: Eighty-three pounds per cubic foot of peat equals 73 pounds of bituminous or 93 pounds of anthracite coal.

It is claimed for peat that it is superior to coal in its absolute freedom from sulphur and the absence of smoke, soot, dust, and clinkers during consumption. In a great measure, this solves the problem of furnishing a cheap, clean, uniform and reliable fuel for all domestic purposes, as it is equally serviceable for grates, stoves, cooking ranges and furnaces, giving a long, bright flame and intense heat almost from the moment of ignition. It has been tested in locomotives with excellent results, showing that the thermal value of 100 pounds of peat is equal to 95·15 pounds of coal. It was also tried at the power house of the Metropolitan Street Railway, Toronto, and gave great satisfaction. The heat produced was much greater than that of coal, but it was 8 per cent. deficient in lasting power. It requires but little draught, and burns best in a shallow fire box.

The machinery used in manufacturing peat fuel is not expensive and requires but little attention when in operation. The company claims that when these works are fairly started it can produce compressed peat fuel for 60 cents a ton. If these claims can be fulfilled, it will be only a few years until artificial heat will become so cheap that the struggling thousands of poor people will be immensely benefited, while at the same time it will also reduce the item of fuel for transportation and manufacturing companies to a minimum.

THE WRECK OF KRAKATOA.

IT is just sixteen years since the most stupendous and appalling of all the convulsions of nature which have occurred either in ancient or in modern times took place. On August 27, 1883, at 10 A. M., the greater portion of the island of Krakatoa, in the Straits of Sunda, was destroyed, while two new islands were created by volcanic action. We (in England) remember the fact mainly on account of the magnificent sunsets which followed the event and were witnessed all over the world. These sunsets, it is now hardly necessary to state, were caused by the impalpable dust and vapor particles which had been ejected from Krakatoa to a height of twenty miles or more from the surface of the earth, and were still floating in the upper air.

The eruption caused a great seismic wave of the sea, which overwhelmed the villages on the neighboring shores and drowned upward of thirty thousand persons. The height of the crest of this wave has been variously estimated, but at Telok Betong, in Sumatra, the water reached within six feet of the Residency, which stands on a hill seventy-eight feet above the sea, and the Dutch man-of-war "Berouw," anchored off the coast, was carried by the wave up the valley nearly two miles inland, and was left, high and dry, more than thirty feet above the sea level.

If a man were to tell us that while walking down Piccadilly he had heard an explosion which had taken place at Guildford, or any town situated some thirty miles away, we should probably think that he was under a misapprehension. But if he told us that he had heard one that occurred at Newcastle-on-Tyne, at a distance of three hundred miles, we should have no doubt as to the condition of his mind. It is, nevertheless, a fact that the explosion of Krakatoa was heard not only thirty and three hundred miles away, but also at a distance of three thousand miles. It was heard in India, and it was heard in Australia, and also in the island of Rodriguez, which is about 2,968 miles from Krakatoa in a direct line. Moreover, the seismic wave of the sea referred to was noticed not only in South Africa, but also at Cape Horn, which is 7,500 miles distant from the Straits of Sunda. But perhaps the most extraordinary of all the phenomena connected with this cataclysm of nature was the atmospheric disturbance, or air wave, produced by the explosion. This air wave, it is stated, went three times around the earth, and it has been remarked that "the character of this disturbance would seem almost incredible, were it not for the fact that it is attested by the barograms of every great meteorological station on the world's surface. . . . From this the time of its genesis could easily be calculated with tolerable exactitude. It is given by Lieutenant-General Strachey as two hours and fifty-six minutes Greenwich mean time, which in local time would correspond with 9:58 o'clock on the morning of August 27."

It may be mentioned that, although the great explosion did not take place until 9:58 A. M., during the whole of the preceding night a continuous roar, like the discharge of heavy cannon or thunder, had been heard, so that the people in the towns and villages of Java and Sumatra were terrified, and did not dare to go to bed. Even on the previous day, the 26th, the sky, we are told, "presented the most terrible appearance, fierce flashes of lightning penetrating the dense masses of cloud over the island, clouds of black matter were rushing across the sky, rapidly recurring detonations were heard continuously, and large pieces of pumice, quite warm, rained down at a distance of ten miles."

It is hardly a matter to be wondered at when we are told that at Carimon, Java, 355 miles distant, native boats were dispatched to assist an imaginary vessel in distress, and at Achern, 1,073 miles distant, it was supposed that a fort was being attacked, and the troops were put under arms. The result of the eruption was that the whole of the northern part of the island, seven square miles in extent, was completely blown away, and where there was formerly dry land there are now soundings of ninety fathoms, and in some parts 160 fathoms or more. Moreover, the bed of the sea some five or six miles to the north appears to have been raised many fathoms. It is unnecessary to point out how stupendous must have been the force generated under Krakatoa at the time of this eruption, seeing

that it was able to lift millions of tons, and sent up a stream of pumice and vapory particles to a height of twenty miles above the surface of the earth. We are naturally led to inquire what was this force, and how was it generated.

The primary source from which proceeds the energy which produces volcanic action is unquestionably the internal heat of the earth. At the base of the crater of a volcano is the top or commencement of the channel or passage whereby communication is maintained with the heated interior; and when water from the sea, or from the underground springs, percolates through the ground, and finds its way down to this channel and to the hot molten rocks below, it at once generates steam, and those of us who have been unfortunate enough to have had a kitchen boiler burst know something of the explosive power of steam, even in small quantities. But the following observations with reference to this subject will give our readers a clear perception of the subsequent stages of an eruption when sea or other water reaches the heated rocks below a volcano.

"The water combines with the material of the rock, and by this combination the melting point of the rock is reduced; it only requires the subjection of the hydrated compound to such heat as would be supplied by the anhydrous lavas in a fluid condition to disengage steam and other gases in enormous quantities, and to produce outbursts proportionate to the pressure and the strength of the inclosing walls. If, while this process is going on, water in large quantities gains access to the surface of the heated mass, solidification might take place, and the escape of gases through the crater would be temporarily checked. When at last the accumulated force bursts the newly formed crust, this and other obstacles would be speedily removed by the tremendous violence of the blast, and the sides of the crater might either be blown away or fall into the seething lava. Such appears to have been the working of the final and self-destructive eruption of Krakatoa."

It is to be regretted that the report of the committee appointed by the Royal Society to inquire into this eruption of Krakatoa and the subsequent phenomena is a quarto volume of such vast and inordinate magnitude that it can hardly be recommended to any one for perusal unless he comes of a family noted for longevity, and can begin it early in life. Seriously, it would have been of more value, and of far greater service, if it could have been reduced to a volume of the size of Bacon's "Essays," or Plato's "Republic," but writers and publishers of the present day seem to imagine that the importance of their works is chiefly indicated by their cubic capacity.—The Pall Mall Gazette.

Chemical Distinction of Amber and Copal.—By O. Rössler. Among the Trojan and Mycenæan finds made by Schliemann are a large number of amber trinkets. To decide the question whether genuine amber or perhaps fossil copal from East Africa is before one, the fact that amber contains sulphur should be borne in mind. If a chip of amber is placed in a small glass tube (melted down at the bottom) and heated, sulphurous fumes will escape, which blacken a piece of filtering paper saturated with lead acetate and laid over the opening. Copals of various origin, however, were found to be free from sulphur. The tested pieces from Troy and Mycenæ proved to be genuine amber.—Arch. Pharm., 1899, 237–9.

TWO AMERICAN ALLIGATOR OR SNAPPING TURTLES.

THE MISSISSIPPI SNAPPING-TURTLE.

THE snapping-turtle so frequently found in the streams and marshes of the southern portion of the United States, particularly in the Mississippi River, is a monster in form and being, according to Brehm. The animal attains a length of five feet, and both in habits and appearance differs from all other tortoises. The slightly arched carapace is formed with three parallel keels; the marginal plates, twenty-five in number, follow one another regularly. The plastron is narrow, and is composed of ten, rarely of eleven, plates. The head is large, flat, triangular, and has exceptionally powerful jaws. The crested tail is remarkable for its length and thickness. Owing to the great length of the tail and neck in comparison with the small body, and to the peculiar scale-like skin which covers all exposed portions of the body, the animal is sometimes called "the alligator-terrapin." The color of the skin is an olive green; that of the upper or dorsal side of the carapace is dark brown, and of the lower or ventral side, yellow brown. In younger animals the colors are lighter. Unlike most tortoises the alligator-terrapin or snapping-turtle is very savage and more active than its fellows. Its food consists chiefly of fishes, frogs, and shells, but not infrequently includes ducks and other water-fowl. Its name of "snapping-turtle" is well earned; for it attacks everything indiscriminately, and its strong jaws are capable of inflicting dangerous wounds. Many are the stories told of its viciousness and tenacity. Weinland states that he has known a snapping-turtle to bite through the blade of an oar. Other observers have given even more remarkable accounts of the animal's prowess. Our illustration, taken from Das Buch für Alle, pictures two snapping-turtles sunning themselves on the sandy banks of a stream after a meal.

HURRICANE IN GUADELOUPE.

CONSUL AYMÉ, of Guadeloupe, under date of August 10, 1899, sends the following details in regard to the damage caused by the hurricane of August 7 in that island and port:

All telegraph and telephone lines are down; the roofs of the great warehouses have been carried off, and the contents ruined; two small steamers anchored in the bay went to the bottom, and two others sank in shallow water; lighters which were engaged in transporting cargo from steamers in port were sunk; boxes, barrels, and cases are strewn along the quays, mingled with the wreckage of small boats, sloops, etc. The western part of the island suffered very little; but on the east, the towns of Gosier, Port Louis, Anse, Bertrand, St. Francois, and the Moule were nearly wiped out of existence. Forty deaths and over two hundred seriously wounded are reported. Desivade Island is said to have but five houses left standing. Even more serious is the damage to the crops. The coffee and cacoa plantations lost 80 per cent. of their products; breadfruit, mangoes, bananas, apricots, cocoanuts, sapodillas, and alligator pears form an important part of the food of these people, especially in the country. The season for these fruits had just begun. The crop is a total loss, and the injury to vines, shrubs, and roots is also serious. Famine threatens the island. There is no Puerto Rican beef to be had, and very little native meat. Many fishing boats were lost. The price of provisions is rising. The loss of property in the city amounts to at least five million dollars.

This is the first hurricane which has swept this island for nearly one hundred years; and, coming as it does after the earthquake of 1897, the fires of 1898 and 1899, and while the island is passing through a serious financial crisis, it will, I think, force the colony to appeal to the outside world for assistance.

COMMERCIAL AFRICA.

"COMMERCIAL Africa in 1899" is the title of a publication just prepared by the Treasury Bureau of Statistics. It shows present commercial conditions in Africa, and incidentally the political divisions as they now exist, and is accompanied by a map showing the boundary lines of the various colonies, protectorates, spheres of influence, and independent states of this great continent, whose map has so rapidly changed during the past few years. A table accompanying the monograph shows the imports and exports into and from each of the divisions. The imports amount in round numbers to $400,000,000 and the exports to $350,000,000, while of the imports, $18,000,000 is furnished by the United States, and of the exports, $10,000,000 is sent to the United States.

Of course the large proportion of the commercial business of Africa is transacted through the British colonies, their share being $131,000,000 of the imports and $132,000,000 of the exports. Next in importance in the import and export trade is the South African Republic, or Transvaal, which is attracting so much attention at the present moment, its imports amounting to $104,000,000, and its exports $54,000,000, the chief exports being gold and other minerals. French Africa imports goods valued at over $70,000,000 and exports nearly an equal quantity; Turkish Africa, principally Egypt, imports $54,000,000 and exports $62,000,000, while Portuguese Africa, whose ports on the eastern coast are adjacent to the gold and diamond fields, is also the scene of commercial activity, the importations being $12,000,000 and the exportations nearly $7,000,000.

Much additional information has recently been brought to the surface regarding Africa through the

opportunities which are now offered for access to the interior. Physically the African continent is in many respects unique. Five thousand miles in extreme length, and over 4,000 in breadth, its area is greater than that of any other continent except Asia, the latest estimates being 11,874,000 square miles. Its coast formation is peculiar in the absence of deep indentations, bays or harbors, and the small number of waterways which offer entrance to the interior. The fact that the greater part of the interior is an elevated table land extending on all sides to within a short distance of the coast renders access to the interior by the few large streams difficult. At the point where the rivers pass from the elevated plateau of the interior to the lowlands of the coast the falls or rapids which there exist prevent navigation, and as a result travel to the interior in Africa by water developed more slowly than in any other continent. Indeed, it was not until the explorations of Livingstone, Stanley, Speke, and others developed the true conditions and made known the fact that vast navigable water stretches were to be found in the interior that it occurred to man to transport steam vessels around these falls and put them afloat in the waterways of the interior. When these conditions were clearly established, however, modern ingenuity and energy soon found a means of transporting steamers in small pieces upon the backs of men through the forests, around the falls and rapids for scores and even hundreds of miles, and putting them together, set afloat the steamers, which penetrate thousands of miles into the interior and develop facts never before known and which could not have been developed by land exploration in tropical climates and jungles for many generations.

ROBERT WILHELM BUNSEN.

With the death of Bunsen there has passed away the last of those great German chemists of the middle of the present century, chemists who bore the greatest part of the work of laying the foundations of the modern science, and through whose efforts their fatherland has taken the first place in chemistry among the nations of the earth. The century began with Wöhler and Liebig; in the next decade came first Bunsen and then Hofmann and Kolbe and Fresenius; perhaps to these we should add Kekulé, who followed ten years later. Wöhler brought to Germany the chemical power and intellect of the Swede Berzelius; Liebig the brilliancy of the French school, where Gay-Lussac, Vauquelin, Thénard, Dulong, Chevreul, and other successors of the "Father of Chemistry" were full of activity. Wöhler, at Göttingen, and Liebig, at Giessen, became the progenitors of the German school. Bunsen and Kolbe were Göttingen boys, Hofmann and Fresenius (and we might add Kopp) were born at Giessen, while Kekulé was a youth in Bunsen's laboratory. This band of men were not merely discoverers of chemical fact and theory; they were the discoverers of men. Hardly a chemist of note to-day in Germany or England or America, who has passed young manhood, but has felt the direct impress of one or another of these men. They have been the world's teachers of chemistry, and to-day how many teachers are using their personal recollections of these their own instructors to inspire the next generation of pupils.

And now the last of these giants is gone. Liebig was the first to be taken, just rounding out his three score years and ten. A decade later and Wöhler and Kolbe passed. The last ten years have seen the death of Hofmann, Kekulé, Fresenius, and now, at the close of the century, a few months only before the hundredth anniversary of Wöhler's birth, Bunsen is dead.

The outward incident of Bunsen's life is quickly told. Robert Wilhelm Bunsen, the son of a distinguished theologian, was born at Göttingen, March 31, 1811. In 1831 he was graduated at the University of Göttingen as Ph.D., and after some study at Paris, Berlin, and Vienna he was appointed privatdocent and then assistant professor at Göttingen. In 1836 he succeeded Wöhler at the Polytechnic School at Cassel, and in 1838 was appointed professor of chemistry at Marburg. Here he remained for several years, went to Breslau for a short time, when he was called in 1851 to Heidelberg. Here he remained active till 1889, when he resigned from service; but he still retained all his old interest in the chemical laboratory. Some time before resigning, he received a very urgent call to the University of Berlin, but he was unwilling to change his home in his old age. He died at Heidelberg, August 16, 1899. Few honors which fall to the lot of chemists but were bestowed upon him. In 1858 he was elected foreign member of the Royal Society; in 1883, one of the eight foreign associates of the French Academy of Sciences. He received from the Royal Society in 1860 its Copley medal, and in 1877 he and his associate Kirchhoff were joint recipients of the newly founded Davy medal.

Bunsen was a broad chemist, confining his work to no one branch of the chemical field. He was equally at home in theory and in practice, and perhaps his most important work consisted in laying foundations on which others should erect the superstructure. He would hardly be called a prolific writer, and yet he is credited with more than a hundred articles, of most of which he was the sole author.

His first published work was in 1834 and consisted of a short note in the Journal de Pharmacie calling attention to the value of ferric oxid (hydrated peroxid of iron) as an antidote for arsenic poisoning. This was the beginning of his work on arsenic, from which he was to receive great reputation, but from which also he was to nearly lose his life. He could not have better shown his pluck and enthusiasm than by attacking the dangerous problem of the organic compounds of arsenic. It was a theme which has cost more than one chemist his life, but it was of great importance in Liebig's work on the "radical theory." More than twenty years earlier Berzelius had said: "The application of what is known regarding the combination of the elements in inorganic nature, to the critical examination of their compounds in organic, is the key by which we may hope to arrive at true ideas with respect to the composition of organic substances." Bunsen followed up this idea, showing that the so-called alkarsin, $As_2(CH_3)_4$ was a radical, but a compound radical, being made up of arsenic, an inorganic element combined with hydrocarbon radicals which are organic. This work of Bunsen's, though of course far less reaching in importance than Wöhler's then recent synthesis of urea, was far more difficult and dangerous, not only than this, but also than Liebig and Wöhler's investigations of the benzoyl radical and Gay-Lussac's study of the cyanogen radical. This work of these four chemists established for the time being the "radical theory," which indeed was to be soon overthrown, but was later to reappear as a part of our theory of to-day.

At the time Bunsen was carrying on his researches on organic compounds of arsenic, he was beginning that series of investigations on the gases in the iron furnace which culminated in the report presented to the British Association in 1845 by himself and Lord Playfair, on the "Gases evolved from iron furnaces, with reference to the theory of smelting of iron." While the utilization of the waste gases of the iron furnace for fuel had been attempted at a much earlier date, it was not till the work of Bunsen, alone and with Playfair, that the enormous waste in these gases was impressed upon ironmasters; so that Bunsen can be said to have largely contributed to this great source of economy in the modern furnace. In other directions also these investigations bore practical fruit.

The study of furnace gases had demanded methods of gas analysis which at that time did not exist. Perfecting the old, originating new, Bunsen built up a system of methods of gas analysis which have remained the foundation of those subsequently used; indeed, he has been called the founder of this branch of analytical chemistry.

In this connection should be mentioned the Bunsen burner, now universally used in chemical laboratories, and almost as extensively outside, as in the Welsbach light. The principle of mixing a proper amount of air with a combustible gas and burning it from an open tube is very simple—after it is known, but it was unknown until discovered by Bunsen.

In 1841 and 1842, Bunsen published his experiments on the use of carbon in the place of the more expensive platinum in the Grove battery. The outcome of this work was the Bunsen battery, which has been one of the most useful as well as the cheapest of all batteries, and which may be said to have refused to yield supremacy until displaced with all other batteries by the dynamo.

Having a powerful source of electricity at his disposal, he re-investigated the methods by which nearly fifty years before Davy had been the fortunate discoverer of so many new elements. Bunsen improved these methods, and made in connection with Matthiessen the first thorough study of lithium, which had been discovered by Arfvedson in 1817, and for the first time the metal was isolated by him.

THE LATE ROBERT WILHELM BUNSEN.

All through this period and for many years later he took great interest in mineralogical chemistry, especially in the chemistry of rock formation. In 1847 he visited Iceland, and soon after published a number of papers on the chemical geology of that island and also on the theory of geysers.

A series of investigations carried out with Sir Henry Roscoe, on photo-chemistry, laid the foundations of actinometry. The work of Daguerre and his followers had just given birth to the art of photography, but the whole subject was up to this time empiric. By Bunsen and Roscoe it was placed on a scientific basis and the way blazed out for the many future investigators in this field.

One further study should be mentioned, that of Bunsen and Schischkoff on the theory of gunpowder. Gunpowder had been known for centuries; van Helmont had stated that its power was due to the production of gas, but beyond this little or nothing was known till these chemists took up the investigation of the gases formed and the powder residues, and formulated for the first time a theory of gunpowder. Here as in other cases the first incentive was given which resulted in the work of Karolyi and Abel and Nobel, and the many present-day workers in the field of explosives.

This résumé is but an outline of the more important work of this great chemist, during the first half century of his life. It was almost at the close of this half century that there was to come, as it were as a crown to his work, that great discovery with which the name of Bunsen will ever be most closely linked, spectrum analysis. For several years he had been interesting himself much in blowpipe analysis, and it seems probable that the key to this discovery came, not as a result of long and patient search, but rather grew from his daily work of laboratory instruction. It was the discovery of the teacher rather than of the investigator. Associating with him his colleague, Kirchhoff, together they worked out the practical application of his discovery, and science stood armed with a new weapon, the spectroscope. Bunsen was the first to avail himself of the instrument and brought forth from the waters of Dürkheim two new elements, rubidium and cesium. Later other new elements have followed, as indium discovered by Boisbaudran and thallium by Crookes, and a host of "meta elements" differentiated only by the spectroscope, the latest of them, victorium, needing not only this instrument but also the camera, to render its "lines" apparent.

But far more important than the mere discovery of new elements was the widening of man's horizon in a new and unexpected way. Spectrum analysis was applicable not alone to those flames we could place before it within the confines of our laboratories; the light of the sun and the stars could be studied equally well and a means was at hand for learning the chemistry of the heavenly bodies. Yet this was not all, for by the displacement of lines the motion of stars and other bodies in line of sight becomes known. Astro-physics is rendered possible by Bunsen's work.

The last of the great investigations of Bunsen were on calorimetry. The Bunsen ice calorimeter was described by him in 1870 and rendered possible specific heat determinations, with quantities hitherto too small for investigation. While from this time his activity was much lessened, yet now and then papers continued to appear from his pen. The last few years of his life, however, were spent in the quiet retirement of the old university town which had so long been his home. As long as he was able, he took great delight in showing visitors over his old laboratory, and the writer will long remember a pleasant hour spent with the old man in his laboratory some years ago, how he showed the rooms and places where this or that historic work was done, and what a delightfully genial man he was to a young stranger.

As the old chemist's sun was sinking to the west there came to Heidelberg, like a brilliant meteor, one whose fame far outshone the older light. All things were changed, the old building passed, a new and magnificent laboratory took its place; again students flocked to the Neckarthal for chemical study, but the discoverer of the spectroscope was almost forgotten. A few brief years passed by, and as the light of the brilliant meteor is suddenly extinguished, so Victor Meyer was no more. But still Bunsen lingered, as if loath that a single year of the century ushered in by his master Wöhler should be left without the presence of one of the giant minds of chemistry. But now he too is gone, and the last link between the past and the present is severed as far as lives go; but upon the foundations laid by Bunsen many a superstructure will continue to rest, and yet many another building will be erected.—James Lewis Howe, in Science.

QUEBRACHO TANNAGE.

By W. Eitner.

Quebracho has been mostly used in Austria in conjunction with pine bark in the tanning of sole leather. It has been found when this material is employed that the hides must be "raised" or "swollen" by the use of some souring agent, and that this "plumpness" must be maintained throughout the tanning process.

With the old method of tanning, the hides were passed through a succession of pits containing old sour tan liquors, which were never thrown away, but merely strengthened periodically by the addition of small quantities of fresh extract and bark each time a fresh pack of hides was placed in the liquor. The effect of such immersion in sour tan liquors (which lasted from four to five weeks) was to produce the desired swelling and coloring of the hides, or the partial tannage or "setting" of the grain. It was generally supposed that a sour liquor with a little tannin would not contract the grain of the hide; in other words, that the tannin was the main cause of this contraction. It is now known that it is to the acid present that contraction must be chiefly ascribed, aided in some degree no doubt by strong infusions of tannin.

The American tanners have indicated the rational method of coloring and swelling hides, viz., by plumping the goods in a short space of time in a perfectly pure and "sweet" liquor, moderately strong in tannin, and keeping them in a state of continual agitation by the "coloring" wheel until they are tanned.

In the case of the new process, in which the meager tanning extracts of pine bark have been strengthened by the addition of quebracho, the sour liquors used are much more effective. Quebracho generates only a small quantity of acid, so that the whole quantity of the latter present throughout the tanning process is relatively very much less than was the case when pine bark alone was used.

The problem, therefore, to be solved is to obtain with sour liquors containing less acids and more tannin an equal degree of plumpness in the hides. It is only quite recently that it has been possible to satisfy the desire of a tanner for a hide perfectly free from lime, but, nevertheless, thoroughly plumped, viz., by the use of certain substances which remove or neutralize lime. Hydrochloric acid may be used, but only in a capacious wooden vat, so that the hides may hang with space intervals of 5 centimeters between each of them. One-quarter of the required quantity of hydrochloric acid is now put into the vat with sufficient water and the hides are suspended for six hours; another quarter of the acid is added and the hides are again immersed, and the process is repeated at intervals of six hours until the whole quantity of acid has been added. The quantity of acid to be used is 10 grammes per kilogramme of green hide. Where a wheel is available, by means of which the liquor is continually agitated, the process of "de-liming" is much quicker. The lime stock treated in this manner begins to swell, and plumps without becoming flaccid, so that the hides, though soft, are, nevertheless, firm in texture, the grain smooth and even, and in this condition they may be introduced without washing direct into the liquors. The first liquor should be at from 10 to 12 degrees B. They are moved on through a series of gradually stronger pits for about 20 days and handled regularly. At the end of this time the grain is thoroughly set, the goods are firm and colored through, and they are in a suitable condition to go into layers. A suitable strength for the layer liquor is about 15½ degrees B., and should consist of about three-quarters of acid liquor and one-

quarter of fresh liquor, and the goods should be dusted down with 3 kilogrammes of coarsely ground pine bark per hide. The latter layers may have 10 to 15 per cent. of quebracho added, with pine bark as dusting material.—Der Gerber. Abstract from The Journal of the Society of Chemical Industry.

[Continued from SUPPLEMENT, No. 1240, page 19884.]

AN ADVANCE IN MEASURING AND PHOTOGRAPHING SOUNDS.*

By Prof. BENJAMIN F. SHARPE, M.A.

ILLUMINATION.

THUS far it has been assumed that the light passing through the train of mirrors of the refractometer, and forming the interference bands viewed in the telescope, has its origin in a sodium flame. But, as a matter of fact, white light is used because of its greater intensity. Consequently the bands are not quite so simple as described, but instead of being alternately yellow and black, they are a series of rainbows with two black bands in the middle of the series. Elsewhere the very dark reds and blues serve the purpose of the black bands and afford a strong contrast to the brighter colors. In computation, of course, a mean wave length of light is employed. The source of the white light is a Welsbach gas lamp. It is very intense, constant, and quiet and serves the purpose excellently. No doubt an acetylene lamp would be convenient and satisfactory for out-of-door work.

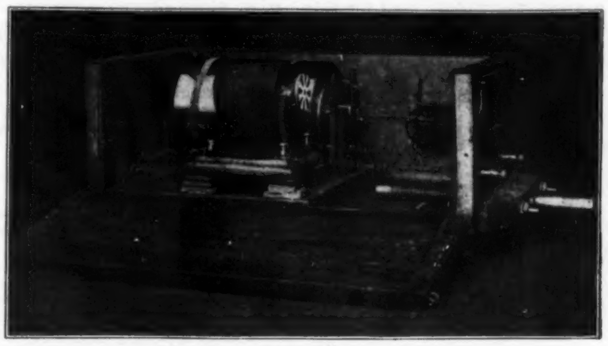


FIG. 12.—The Camera, with Shutter and Lens Turned Away.

A CAMERA TO PHOTOGRAPH SOUNDS.

For photographing sounds a good electric arc lamp is required, because the time of exposure is extremely short. Indeed, the arrangement is quite different from the one used thus far in direct observation. The photographic film does not precisely take the place of the retina of the eye—but the telescope with its vibrating object glass is removed, and a single fixed lens is substituted, which focuses the interference bands upon the film. This film is wound about a horizontal cylinder kept in constant and rapid rotation, as was attempted by Raps.† Here again we make use of the principle of the composition of motions. Only in this case we have added to the lateral vibration of the bands, due to sound, a steady motion in the vertical direction, instead of an oscillatory one up and down. Consequently the result is different. The screen with the narrow horizontal slit is now set as close as convenient to the film, so that, with the cylinder at rest, and with no sound, a strip like Fig. 11, only very much smaller, is focused on the film. If now the cylinder rotates, this strip will be continuously printed on the film, the result being parallel bands with straight edges, like the photograph of quiet, Fig. 11. But any sound added now will cause a vibration of the points of the strip sidewise, and the result will be a set of parallel, wavy bands, such as in Figs. 15 and 16.

The accompanying Fig. 12 shows the inside of the camera. The lid has been removed and the back let down. The cylinder is shown belted to a small dynamo, which is almost completely covered with black cloth to prevent its sparking from fogging the film. But the pulley is shown, with black and white sectors upon its face. This is part of a stroboscopic device to observe and regulate the speed of the motor. Opposite this disk is a ruby glass window in the camera, for the purpose of viewing the disk. But this inspection is made between the tines of another tuning fork in vibration, as shown in Fig. 13. Two little screens, S, are fastened to the ends of the tines in such a way that they barely meet when the fork is still, but in vibration, slide over each other without touching. Thus the view is interrupted once during each complete vibration. Now, if the disk turns just fast enough for one of the black sectors to advance to the position of the next, during the interval that the screens are closed of course the disk will appear to be at rest. This rate of motion is secured by feeding the motor with a constant current of just the right strength. This again is no easy matter, but a Continental scientist, Lebedew,* only a short time ago, devised a method of accomplishing it satisfactorily. His method consists in the arrangement shown in Fig. 13. The current through the motor enters at T, and passes out at T'. In so doing it passes constantly through the resistance, R_1, which is not quite large enough to slow down the motor as much as desired. R_2 is a second resistance, which added to R_1, would slow down the motor too much. But a shunt through the tuning fork cuts out R_2 periodically, that is, for a portion of each fork period, thus bringing down the average resistance to the required amount; for the shunt circuit is regularly opened and closed at two places; at the upper platinum connection on the fork, and again at the accessory commutator, A, of the dynamo. If the shunt is closed at both places during the same interval, evidently R_2 is shunted out during this interval, and the motor gains in speed. But if the connection is broken at one or the other of these two places during the entire period of a fork vibration, then the current must pass through both resistances, $R_1 + R_2$, and the motor is slowed down. Accordingly an automatic balance can be found between these two tendencies, by adjusting R_1, R_2, and the platinum contact, such as will give constantly the speed desired. The regulation is automatic, because the acceleration of the motor itself puts in more resistance, and vice versa. The fork, F, is driven by an independent current, and is provided with a box having glass windows, as in the case of the fork of the object glass. By suitable pulleys, a speed of about three revolutions per second is given to the cylinder, and since the shutter slit is less than a half millimeter in vertical width, and the cylinder is 50 centimeters in circumference, it is evident that the time of exposure is less than one three-thousandth of a second; consequently a very intense light is required.

But the time of exposure differs from the time that the shutter is open, for during this interval a series of pictures of the size of the shutter has to be made entirely around the cylinder, unless we wish to waste our film by blank spaces, or by overlapping pictures. It is therefore desirable that we make the shutter open for precisely a third of a second at each exposure. This is done by the device represented in Fig. 14. The shutter, A, is at the end of a long lever, operated by an electro-magnet, H. The armature, I, has a hinge motion by means of the thin, flat spring, V, which is firmly clamped at the end represented toward the right hand of the figure. The current from the battery, O, passes down the pendulum of the clock, which beats seconds, and around through the electro-magnet, provided that the platinum point of the pendulum happens to be passing through the mercury, M, and provided also that the key, T, is closed. We adjust the width of M so that the pendulum is in contact with it during about half of one swing; then, to make an exposure we close the key at the beginning of a swing in either direction, taking care to open the key when the swing is completed. This is best done by having the clock where we can see it. The ticking is no disturbance, for it dies away before the shutter is opened.

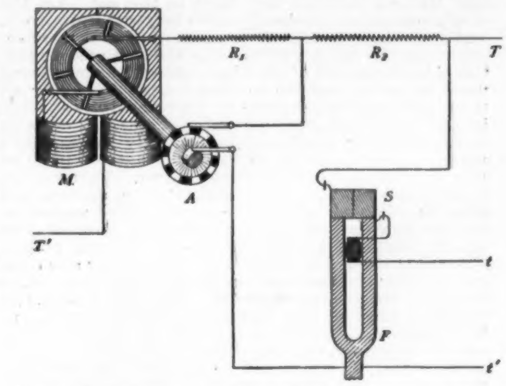


FIG. 13.—Device for Regulating the Speed of the Motor.

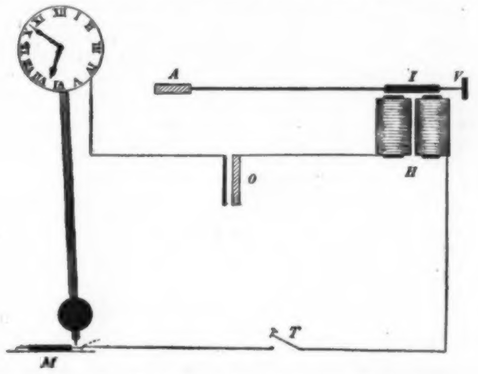
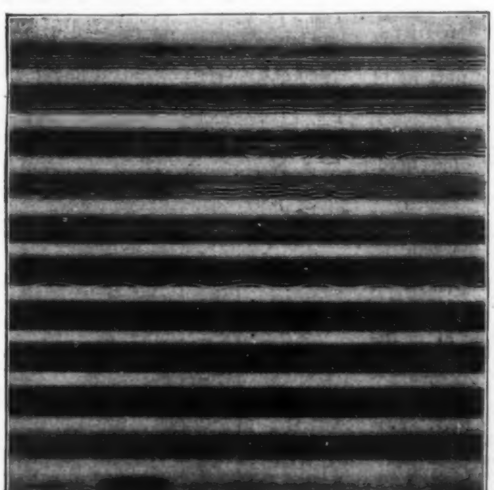


FIG. 14.—Device for Opening the Shutter.

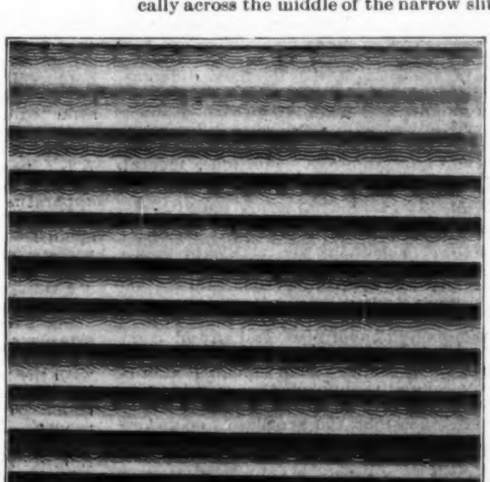
THE UTILITY OF A CAMERA FOR SOUNDS.

With such a camera we may photograph sounds of any sort. Fig. 15 gives a number of photographs of tones and combinations of tones. The straight, narrow, white line along the middle of each photograph is produced by the shadow of a fine wire, stretched vertically across the middle of the narrow slit of the camera. This line is not shifted with the bands, so it affords a convenient position from which to measure the displacements of the bands. When picture No. 1, Fig. 15, was taken, the room was very quiet, so far as the ear could discern. But it appears that the instrument was more sensitive than the ear, for otherwise these lines would have been as straight as the reference line. Instead they show small oscillations of the little mirror, and therefore a sound is revealed. A strong tone causes a wide displacement, like No. 12, while a weak tone



1. Quiet.
2. Fanning I.
3. Fanning II.
4. Noise.
5. Flageolet.
6. Fork C_{128}.
7. Fork c_{256}.
8. Fork c'_{512}.
9. Forks C + c.
10. Forks C + c + c'.
11. Forks g + a.
12. Forks c + e + g + c'.
13. Tone source.

FIG. 15.—Photographs of Pure Tones and Combinations of Tones.



1. (a)h.
2. (o)h.
3. p(oo)l.
4. (a)te.
5. m(ee)t.
6. s(e)t.
7. (a)t.
8. (i)t.
9. (au)ght.
10. (e)re.
11. (u)se.
12. (u)rn.
13. Fork c_{256}

FIG. 16.—Photographs of Vowels.

* From the Monthly Weather Review, published by the United States Weather Bureau.

† Wied. Ann., 1893, Band 50, p. 194.

* Wied. Ann., 1896, Band 59, p. 118.

causes less displacement, as in No. 13. If the tone is high in pitch, the wave length is short, like No. 8, but a low tone gives a long wave, like No. 6. By comparing the number of waves in a given length we find that the flageolet was blown on *F* in the fourth octave above No. 6. This fact could not be determined by the ear. Again the flageolet was blown with utmost intensity and produced a painfully loud and shrill sound, while the tuning fork of No. 6 was touched very gently and its tone sounded very faint to the ear. Yet the displacements are evidently much larger than in No. 5, and accordingly a tone of low pitch has in it more energy than one of high pitch, since the energy is proportional to the square of the displacement; hence the ear must be more sensitive to high tones. In taking all these pictures the influence of the resonator was eliminated by removing the resonator. This was done by simply screwing it off and leaving only the sensitive plate. It was desirable to know the natural pitch of this plate loaded with the little mirror. This was accomplished by opening the shutter of the camera just after fanning the plate once gently. The motion of the air displaced the plate slightly, and in coming to rest it swung to and fro in its own natural period. This is shown well in No. 3, and by counting and comparing wave lengths again we find its pitch is G flat, or about 186 vibrations per second. The record begins on the right hand of each figure, and the motion was at first somewhat irregular, because the air near the sensitive plate was still disturbed by the fanning. But it appears that, as we proceed to the left, the plate soon settles down to a regular motion. This photograph is selected to show how this motion begins, and is taken from a film 20 inches long. It would appear from the pictures produced by tuning forks sounding together that a discord, like No. 11, gives sharp waves, while for forks in harmony the combined waves are round and smooth, as in No. 12. The perfection of our source of tone is shown in No. 13.

It will assist in forming a conception of what is represented in these photographs, if we place these long bars in a vertical position before the face. Then, if the film were at rest, and if the exposure was extremely short, the picture of the interference bands would be like a strip cut out horizontally across one of these bars, less than a half millimeter in vertical height. The picture contains the exact position of the interference bands at that instant. Now, suppose the film is moving rapidly upward. At each successive instant the photographic film records the changing position of the bands, because the vertical position of the strip on the film is changing simultaneously. Consequently, each photograph is a chart, showing continuously the changes in atmospheric pressure due to sound.

The cylinder covered with the film is moved along in the direction of its axis after each complete photograph, by turning up the screw shown in connection with the camera. Its handle projects to the right, and its point bears against the base of the carriage which carries both cylinder and motor. This carriage slides smoothly and easily upon the base of the camera, by the motion of the screw, without opening the camera or stopping the motor. With this apparatus ten feet of such sound photographs have been taken in as many minutes; with a simple arrangement for winding a long, narrow film continuously from one cylinder upon another, a similar photograph may be taken of an entire oratorio or address.

Fig. 16 represents photographs of the vowel sounds occurring in the words indicated.* These vowels were sung by the author as distinctly as possible, but rather softly, upon the note an octave below middle *C*, or upon the *C*, having 128 vibrations per second. The resonator had been removed, as before, so that the sound waves acted directly upon the sensitive plate. Each vowel is represented by seven complete waves. The degree of smoothness of utterance in each case is shown by the uniformity of these waves. Ideally, every wave in each curve should be exactly alike, though each curve should be characteristic of the vowel. Of course, the height of the waves may change, for that depends simply on loudness. The length of the waves depends on the pitch on which they are uttered, and that may change too, as indeed it does, in the inflections of speech. Moreover, since different people have individual peculiarities of speech, so that they do not pronounce the same vowel exactly alike, these vowel curves are actually somewhat different in other respects also, for different people, and even for the same person under different conditions, mental and physiological.

THE ANALYSIS OF PHOTOGRAPHS OF SOUND.

The analysis of vowel curves shows that their characteristic differences consist in the relative predominance of one or more overtones. But this statement should not lead any one to make a crucial test by attempting to construct a vowel by any combination of notes on any musical instrument. For each note is itself a whole symphony of overtones, and any addition of them would be haphazard. But even a carefully studied combination of tuning forks, though it affords a recognizable vowel in the simpler cases, is subject to some limitations, so that it would not sound entirely human.† It seems then that the synthesis‡ of vowels is practically more difficult than their analysis. A number of very complicated machines have been constructed for analysis.§ A recent one, by Prof. Michelson, separates a curve into eighty harmonic components.‖ To prepare one of our vowel curves for his "Harmonic Analyzer" we would enlarge it considerably, e. g., by projection with the lantern, trace it on sheet metal and cut it out. The wavy edge is then fed into his machine, and for a result we obtain numbers representing the proportional strength of the first eighty overtones. A wonderful machine!

From any of our sound photographs a measurement can be made of the intensity of sound, on virtually the same plan as the one already mentioned, that is by the displacement of a given band from its mean position. This displacement is read by means of a micrometer microscope applied to the film itself, or by means of a lantern projection. We have already ascertained that each displacement of the bands corresponds to a definite motion of the sensitive plate which carries the little mirror. A mathematical relation connects this motion with the condensation of the air within the resonator, another relation connects the condensations within with those without; so that, thus, there is a complete chain of relations, having at one end the displacement of the bands and at the other the energy in the sound.

Besides all the various physical and physiological problems before mentioned in this paper, whose data may be obtained in permanent records, some additional ones may be attacked with this photographic apparatus. For instance, it will be of interest to know why the same note on two different musical instruments, e. g., violin and flute, should be so different in quality. The comparison of photographs of these sounds would answer the question. Similarly we may investigate the physical peculiarities of any sound produced by man or in nature.

* Cf. Hermann's work, Phonophotographische Untersuchungen, Bände 53, 58, 61, Archiv fur Physiologie.

† Helmholtz, Sensations of Tone. Note by Ellis, p. 543.

‡ Preece and Stroh. Proc. Roy. Soc. Vol. xxviii., p. 358.

§ Jenkin and Ewing. Trans. Roy. Soc. Edinb. Vol. xxviii, p. 745.

‖ A. A. Michelson and S. W. Stratton. A New Harmonic Analyzer. Am. Jour. Sci., January, 1898, (4) v., pp. 1-13; also L. E. D., Phil. Mag., January, 1898, (5) xlv., pp. 85-91.

BOATS AND SAILS.—I.

TOOLS FOR TESTING BOAT MODELS.

By WALTER BURNHAM.

THERE have been a great many tools used for this purpose. Some of them, nearly all of them, have defects. The tool used in these experiments is explained, that all may form their opinion of it. I refer to the sketch herewith. The sketch is a mere outline intended to convey an exact knowledge.

PLATE I.

In Fig. 1 *A A A* are the walls of a tank about 4 feet wide and 10 feet long, with 8 inches of water. *B* is a boat, that is to say, it is a half of a hollow copper sphere. This form was chosen because it moves through the water in all directions with exactly the same resistance. *C* is a piece of lead fastened in the hollow copper sphere to counterbalance the arm, *H H H*. *D* is a dial subdivided into ten parts, and these again subdivided into quarters. By turning the thumb screw, *E*, to which the arrow, *F*, is attached, the number of turns or parts of a turn of *E* are indicated. *G* is

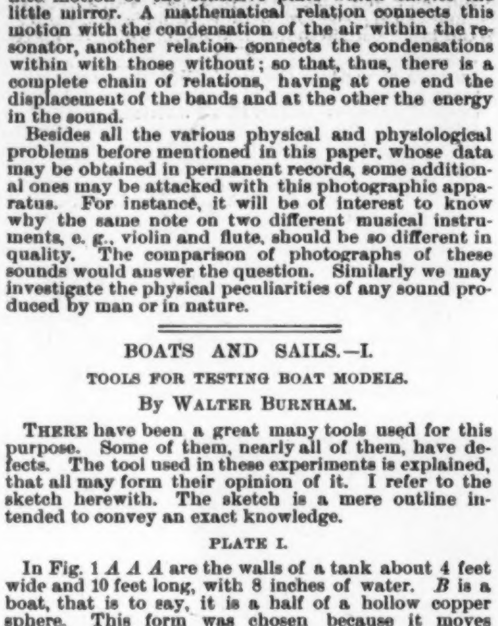


PLATE I.—APPARATUS FOR TESTING MODELS.

a ring fastened to the copper vessel for the purpose of holding it back at the beginning of its voyage. *H H H* are the fragments of an arm about 3 feet long that was attached to the copper vessel firmly. *J* is a pin in the end of the arm to which the vessel to be tried is hooked. *K* is a post around which the double chord, *L L L*, passes, as well as around the shaft of the thumb screw, *E*. *M* is the rope or string by which the whole apparatus is moved through the water. *N* and *O* are forts fastened to the tank side and extending outward, against which the copper vessel, *B*, and the arm, *H*, will strike. *P* is a pin with its end bent into a ring to fasten around the pin, *J*, in the end of the arm, *H*. *R* is a thin piece of wood fastened by the two pins, *S S*, on to the model to be tried, *T*.

Fig. 2 represents the same things looked at in the side elevation, *V V* being the waterline.

Fig. 3 is a sectional view of the hollow copper sphere with the waterline at *V V*. This hollow copper sphere has the wooden piece, *W*, cemented in its bottom. The thumb screw, *E*, with its shaft entering *W*, turns around. As it turns it draws the near side of the line, *L*, toward itself. When turned in the opposite direction, it draws the opposite line toward itself. *F* is the index arrow. *C* is the lead which counterbalances the arm, *H*. *H* is fastened in by being tacked to the wooden piece, *Y*, which is fastened into the copper sphere.

Fig. 4 is a side elevation of the model, *T*, and the holder, *R*, and shows how the bent pin, *P*, hooks around the pin, *J*, in the head of the arm, *H*, *V V* being the waterline. There is a hole through the holder, *R*, which indicates the bow.

The operation of this device proved perfectly satisfactory. The model, *T*, was made of straight lines and very exact. When an experiment was to be made, *T* and *B* were drawn back to the lower end of the tank and held by pins that entered *G* and *P*. These two pins were simultaneously released, when the weight on the far end of *M* (which passes over a pulley) drew the copper sphere and the model, *T*, forward through the water.

The resistance of *B* and of the model, *T*, differs, so that if *M* took hold at 960, for instance, *B* would strike the fort, *N*, long before the arm, *H*, struck *O*, whereas if *M* took hold at 50, the opposite would be the case. A model would be put on and the device hauled back to the foot of the tank.

By turning *E* as the numbers read, it is seen that the attachment of *M* to the chord, *L*, is drawn toward *E*, and the opposite turning of *E* draws the attachment of *M* toward *K*. The model was tried and tried until the adjustment of *M* was such that *B* struck *N* at the same instant that *H* struck *O*. This striking of *H* and *B* was the most delicate adjustment found, for if *B* struck *N* the shortest interval before *H* struck *O*, *B* would rebound, and vice versa.

When I had succeeded in getting the striking simultaneous, I then looked at the figures on the arm, *H*, and found the tens and hundreds, and on the dial, *D*, the units. For example, the standard model, *T*, when one of its ends was used as the bow, always registered 505¼; when the opposite end was used as the bow, it registered 498. The model, *T*, I kept for a standard, and whenever any peculiar or striking result was obtained, I immediately verified the apparatus by using standard model, *T*.

The holder, *R*, was fastened to *T* by the two pins, *S S*, as shown in Fig. 4. These pins I could pull in and out, always putting them in the same holes. I always used the holder, *R*, on all models, and always fastened it to the model through the old holes.

The connection of the model to the holder and the holder to the arm by the pin with the ring in the end of it, which slipped down over the pin, *J*, in the end of the arm, I found very serviceable, because with it, it made a long pull, and the depth to which the model sunk or rose in the water was allowed for by the hook sliding up and down the pin.

The weight which I used on the end of the chord, *M*, was a cork into which I stuck twenty pins for medium speed, ten pins for slow, and forty pins for fast.

All models were made with the greatest exactness, were boiled in beeswax to secure exactness of weight by keeping out of the water, and were then rubbed smooth, when, if their weight was found slightly lacking, they were covered with shellac.

Assuming that the testing apparatus is understood and that the models used are explained, the results which follow are particularly interesting when it is known that they were tabulated and made relative in the following manner.

A large quantity of muslin a yard wide was rolled up on a roller and hung at the ceiling with the end hanging down. One foot from the left hand edge was drawn a perpendicular mark on the muslin. In the space to the left of this mark was traded the model. Then a rule in the shape of a yard stick was numbered to agree with the numberings on the arm. As there never was found a model that was so great a drag as to cause the attachment of *M* to be at 10, or so very light that *M* might be moved to 1,000, the numbers between 200 and 800 were the only ones that were used. When then a model, as for instance the standard model, *T*, registered 505¼, when *B* struck *N* at the same instant that *H* struck *O*, I laid the yard stick on the muslin with 505¼ sticking out to the right of the perpendicular line and drew a lead pencil mark 505¼ long. When I reversed the standard model, *T*, and it registered 498, I marked it similarly. It is apparent that the relative speed of the model with one end foremost and then the other end could instantly be seen by the relative length of the two speed lines. The muslin gradually became a very valuable and interesting record of results, for to the left of the perpendicular line were the models, to the right of it, the line of their speed. For slow speed I used a blue lead pencil, for medium a black, and for fast a red. On the speed line was written anything peculiar about the model or the trial. Very great care was used and every effort made to keep the apparatus in order and to make the trials exact. The following are the results obtained through the use of this apparatus with models.

BOW AND STERN.—PLATE II.

Fig. 1 is here an ordinary scow bow. 2 is a straight line bow. 3 is an interior curve. 4 is an interior and exterior, and 5 is altogether an exterior. The greater speed of 5 is very marked, although 2 follows it closely. 3 and 4 could be carried on 5 as a deck-load, and it would still equal the speed of 1. These models were then used as sterns in 2 5, 3 5, 5 2, and 5 3.

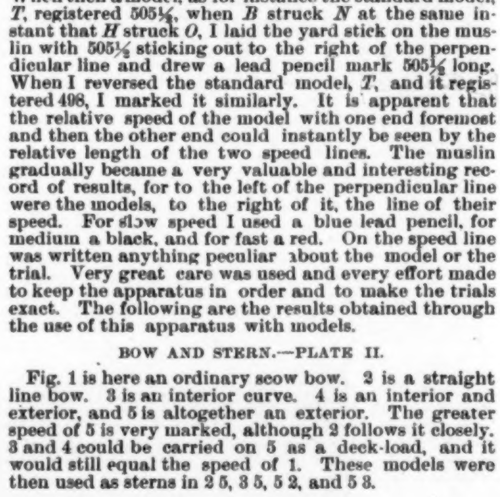


PLATE II.—THE BEST FORM OF BOW AND STERN.

In this sketch no effort has been made to keep the relative speed between models of different weight, correct, as it will be seen that the speed line for 5 3 is longer than the speed line for 3. I have had to make the drawings true in relative speeds with only a certain group of models, because the width of the paper is not sufficient to register relatively correct the speed of models of different weight. Most certainly 3 was faster than 5 3; it weighs half as much.

When models of different weight are compared to-

gether, the speed line is made relatively correct, and if comparison is to be made between models of different weights, the cloth is broken by the continuous irregular line across the page, it being understood that all of the tests are not here shown.

BEAM AND DRAUGHT.—PLATE III.

Fig. 1 is a block of wood twice as long as it is wide and about half an inch thick. Through it are two holes, shown at 5 5. These holes run clean through the model, and in them are four buckshot. When the model is to be tried lying flat, the buckshot are pushed into the center and the ends of the holes corked up. When it is to be tried edgeways, the four buckshot are

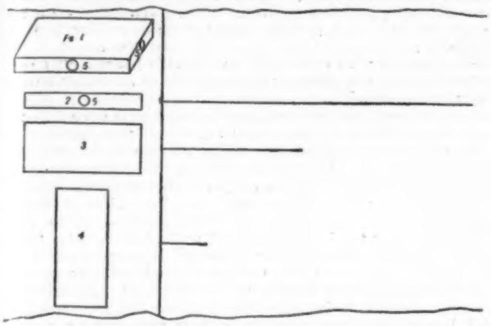


PLATE III.—EFFECT OF BEAM AND DRAUGHT ON SPEED.

pushed down to the bottom, and end-ways, the same. By this means, it is apparent that the model remains at all times the same in weight and exterior dimension, and it was sunk almost flush with its upper edge.

2 represents a boat of the skimming-dish kind, that is, very little draught and great beam. This form has a marked increase of speed over the same model when drawn through the water with its edge down or with its end down. 3 represents medium draught, and 4 great draught.

In 3 and 4, while the beam seems to be the same, it is not in truth relatively the same, because the length differs.

BEAM—PLATE IV.

Fig. 1 has its sides concave, that is, the greatest beam is at the bow and stern. On the sides of 1 are placed the pieces 2 2, and again the pieces 3 3, and yet again, the pieces 4 4, with a constant increase in speed. This increase seems quite unaccountable when it is considered that the pieces, 4 4, must make it weigh a great deal more, but the addition of 4 4 has also the effect of making the boat draw less. The original model was

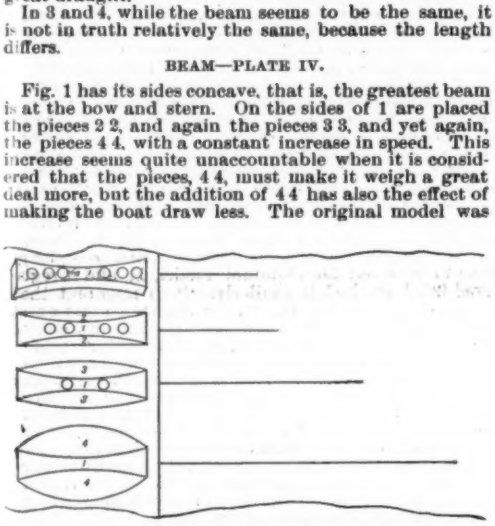


PLATE IV.—EFFECT OF BEAM ON SPEED.

then weighted with six weights that were equal to the weights of 2 2, 3 3, and 4 4. When 4 4 was attached, there were no weights used; when 3 3, one pair of weights; when 2 2, two pair of weights. In this way the weight of the model was kept the same without materially affecting its former speed line; that is to say, the greater beam always went the faster until the beam was three-fifths of the length, then it began to slow down.

LOCATION OF THE GREATEST BEAM—PLATE V.

Fig. 1 is a model 21 inches long and 1 inch square, marked off in inch section. 2 2 are two pieces of wood, each 2 inches long and 1 inch square, attached to number 1 by pins. This model was tried with 2 2 attached

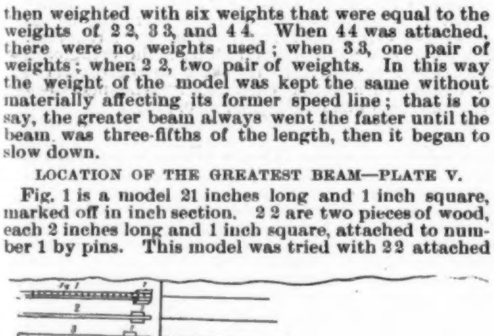


PLATE V.—LOCATION OF GREATEST BEAM.

at the bow, then 2 2 is attached an inch back, and in Fig. 3 it is attached 3 inches back, the speed line constantly increasing, and increasing in a greater ratio, until Fig. 8 is reached, at which the side blocks are two-fifths of the entire length back from the bow.

DRAUGHT—PLATE VI.

In this experiment, a block of wood ½ inch wide, 10 inches long and 5 inches deep, is used with a concave bottom; then piece 2 is put on it, then pieces 3, 4 and 5. Weights are used in the original block, which are taken

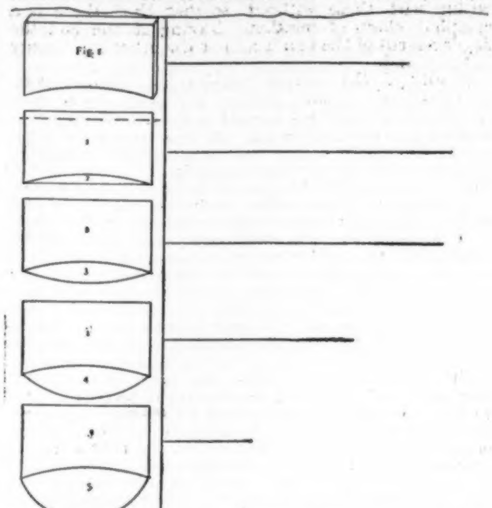


PLATE VI.—DRAUGHT.

out as pieces are put on the bottom. It was submerged to the water line, *V*, so that the only change made is increase of the draught with a constant falling of the speed line.

LOCATION OF GREATEST DRAUGHT—PLATE VII.

This model is 21 inches long, 2 inches wide, and 1 inch deep, with the piece 2 inches long and wide and 1 inch deep. The speed line constantly increases as it is moved aft until 15 is reached, at which point it is nearly one-quarter the entire length from the stern. These experiments would seem to indicate that the

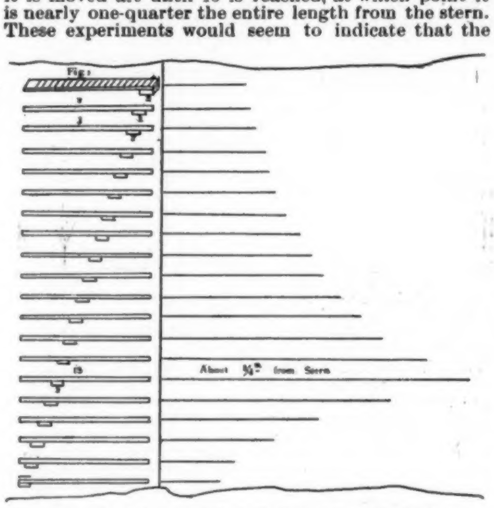


PLATE VII.—LOCATION OF GREATEST DRAUGHT.

point of greatest beam must move aft as the draught is increased, that is to say, while at the surface the greatest beam may be two-fifths from the bow, one foot under the water the point of greatest beam should be further aft; at two feet under the water still further aft, and so on.

KEEL AND CENTERBOARD—PLATE VIII.

The Model No. 1 was used with the centerboard (a piece of tin) lying on its deck as a load. This piece of tin was then attached to the bottom as a keel, and next tried as a centerboard. The lines of speed are given, and it would go to show that the same side

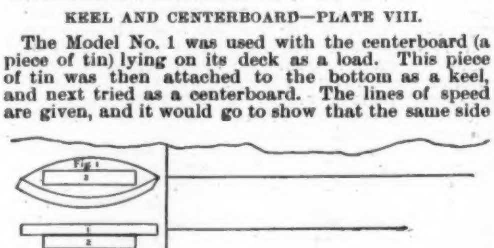


PLATE VIII.—KEEL AND CENTERBOARD.

resistance when secured by a keel moves very much easier through the water than it does when that same area of side resistance is afforded in a centerboard. The usefulness of a centerboard in distinction from a keel is when the boat is sailed in occasional shallow waters.

FORM OF HULL—PLATE IX.

In Fig. 1 the semicircle, *E, F, G, D, H, J, K*, is supposed to be the midship section of a boat, and the line *A, B, C, D*, to be its bow or stern line.

It will be seen by Fig. 2 that lines drawn to all parts of the circular midship line from the straight bow line, result in making hollows at certain places, so that the waterline of a boat may be that shown at Fig. 3, whereas the form of the hull a few feet below it and parallel to it must be that shown by Fig. 4; while deeper still it results in that shown by Fig. 5.

By reference to "Bow and Stern" models, it will be seen that Figs. 4 and 5 are very poor. This is why the present form of fast yachts has departed from the old form, which is that shown at Fig. 6.

By reference to Fig. 7, it is apparent that the curved

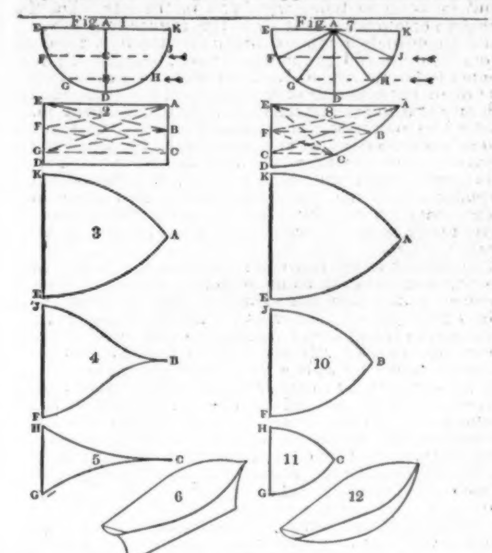


PLATE IX.—FORM OF HULL.

midship section, *E, F, G, D, H, J, K*, and a point, *A*, can be reached in every part from the curved bow line, *A, B, C, D*, by lines that do not cause hollows, which results in the waterline shown at Fig. 9, below it Fig. 10, and yet below that Fig. 11, which are very desirable forms. This is why the present model of fast yachts has taken the form shown at Fig. 12.

WASHING TO FORM.

Exactly what form is best can only be predicted of a boat that is to move through perfectly quiet water at a fixed rate of speed and with a certain load, and to which boat the impulse to move is to be imparted at a certain point (a steamship having its impulse imparted at the stern, whereas a sailing boat has its impulse aloft from the sails, and a canal boat forward at the bow).

Some experiments were made by taking a piece of clay and subjecting it to a current of running water, hoping that the form which the clay was washed into might result in showing some facts, but it was found that currents would set up in the water from the very presence of the clay, which had an effect on the clay, and no two experiments would result in the same form.

It was also attempted to learn something of form by learning where the water struck with the greatest friction against the sides of the boat when drawn through the water. For this purpose, a model of a usual form of boat was made and treated with beeswax and then covered with black shellac. It was then painted with white water color paint, allowed to dry thoroughly, and then placed carefully in the water. After sufficient time to thoroughly soak the paint, it was supposed that if the boat was then moved, the places where the water struck with the greatest force against the boat would have the white paint washed off.

Judge of my surprise when I found I could not wash the white water color paint off the boat by drawing it through the water at the highest rate of speed that I could reach. I then thought the paint could not have dissolved, and lifted the model from the water for examination. On lifting the model the whole shell of white paint remained in the water. It was attached to the model so slightly that it could not be lifted from the water with the model, but dropped from it. Repeated experiments verified the fact that the water through which a boat passes does not seem to rub against the sides of the boat in the usual sense of "rubbing." The fact that dirt, moss, seaweeds, barnacles, etc., gather on the bottom of boats forward as well as aft points in the same direction. I had to cover the model with a mixture of molasses and pumice stone before I could get any effect from the "friction" of the water. I accounted for the rubbing off of the mixture in certain places by the fact that the particles of pumice stone stuck out beyond the general surface and caught the water. Fish are covered with a soft matter that does not wash off. Looking over the side of a moving steamship and aft of midships, one can see the water rolling in little eddies near the sides of the vessel.

The above facts, it seems to me, should be remembered when thinking of "skin friction." There may be something in the effect of a boat on water similar to what I speak of later as the difference between "impact" and "pressure" of wind on sails.

EFFECT OF BOAT ON WATER.

When a boat about 6 inches long was drawn through the tank of water (which was 4 × 10 feet, and 8 inches deep) it caused a disturbance in the water about 2½ feet ahead of itself. This fact was learned by placing mirrors in the tank on the bottom and letting a ray of light fall diagonally on the mirrors, and from the mirrors thrown upward on to the ceiling. A steamer going up a narrow river will cause the water to rise on the banks ahead to a distance of many times the length of the boat, whereas the water will fall away from the banks to its original level very quickly after the boat has passed.

While much is known about the philosophy of a boat passing through the water, there yet remains much to learn.

(To be continued.)

THE MODERN WARSHIP AS COMBINING IN ITSELF THE HIGHEST RESULTS OF SKILL, INGENUITY AND SCIENTIFIC KNOWLEDGE.*

Before proceeding to discuss the subject which has been assigned to me, I desire to express the great pleasure I feel in being with you on this important occasion, celebrating as it does the foundation of an institution which has done so much for the advancement of engineering and the mechanic arts. As one whose whole life from boyhood has been spent in connection with one of the branches of engineering, I feel an especial pleasure at being permitted to assist at this celebration. I want also to express my high appreciation of the honor which has been paid me in asking me to be one of the speakers. I do so with added pleasure from the fact that a great deal of the work with which I have been specially associated has been constructed here in your own city, and by men much of whose training in many cases has been due to the Franklin Institute.

The subject which has been assigned me is one of the greatest interest to an engineer, for the modern warship is the complete fruition and triumph of many branches of the great science of engineering. Although in the ultimate analysis we owe everything to nature, we may well say that in the old wooden ships propelled by sails a very large proportion was due almost directly to nature, with only a minor part played by the artisan and the engineer; while in the modern ship, nature's part is strictly confined to the crudest of raw materials, and the finished product represents, as the title of my remarks so well expresses, the highest development of skill, ingenuity and science in engineering and the mechanic arts.

Under the circumstances of this discussion, we may be pardoned if, in a retrospective consideration of the subject, we limit our review to steam vessels, for the reason, as I have already remarked, that the part of the engineer (using that term in its broad sense) in the old sailing vessels was exceedingly limited. We shall, by contrast, be enabled to appreciate more fully the wonderful entity which we call the modern warship if we consider the first one.

It will interest you all very much, I am sure, to know that the first steam war vessel in the world was built for our navy and was designed by Robert Fulton, who first made steam navigation at all practicable; and the construction of this vessel antedated the founding of this Institute only about ten years. This first vessel was called the "Demologos" or "Fulton the First," and while of what would now be considered very small dimensions, was, nevertheless, a wonder of the period. She was 156 ft. long, 56 ft. beam and 20 ft. deep, measuring 2,475 tons, having a single water wheel in a central well, and capable of steaming about six knots. The battery comprised twenty guns of the largest size at that date, a number of them having been taken from a captured British vessel. The hull, of course, was of wood and the boilers were of copper. She was not completed until just after the termination of the war of 1812, so that she never saw any active service, and was blown up by an explosion of her magazine in 1829.

The next steam war vessel, also called the "Fulton," and completed in 1837, was somewhat longer than the first "Fulton," but with less beam, and proved a very successful ship for the period, being capable of steaming twelve knots per hour under favorable conditions. A most interesting thing in connection with this old vessel is the fact that the engineer who designed her machinery and superintended its erection became her chief engineer when she was commissioned and thereby became the first engineer in the United States navy.

This distinguished gentleman is still alive and in the active practice of his profession. Doubtless many of you will at once know that I can only refer to Mr. Charles H. Haswell, known to every mechanic in the United States as the author of Haswell's Pocketbook. I think we may all take great pleasure in the thought that this venerable and distinguished gentleman, who is not only the Nestor of our profession but one of its chief ornaments, has been spared to see the growth of the war vessel from the original "Demologos" to our "Oregon" and "Minneapolis," and the merchant steamer from the original "Clermont" to the "St. Louis" and the "Campania."

After the building of the "Fulton," steam vessels were added to the navy at regular intervals, each class marking an improvement on the preceding ones until shortly before the commencement of our Civil War we had a class of fine frigates, which in ordnance, machinery and hull were justly considered the finest in the world.

The necessities of the Civil War, of course, gave a tremendous impetus to naval construction, and at this period we have the beginning of the evolution of the modern war vessel. In engineering as applied to machinery and hulls, several names stand out preeminent at this period, and as strictly germane to my theme I may mention the work of two of them. The Engineer-in-Chief of the Navy during this period was Commodore Benjamin F. Isherwood, an engineer whose practical skill, ability as a designer and high scientific attainments have never been surpassed. One of the problems which we had to solve was the construction of machinery which should be thoroughly trustworthy in the hands of men of very limited experience. This led him, contrary to what would ordinarily be considered good designing, but which, under the circumstances, in my opinion, was consummate engineering skill, to build machinery very heavy, but which, as a matter of fact, never broke down and which carried our guns to victory. In those days, just as in our own, the "man behind the gun" may be most in evidence, but without the "man behind the shovel" he would never have been able to get within range of the enemy.

The destructive career of the "Alabama" had led our authorities to decide upon the construction of a class of vessels which should be faster than any others afloat, in order that these commerce destroyers might be hunted down and themselves meet the fate which they had so often dealt out to others. Here, again, Isherwood's consummate skill and mastery of his profession showed itself. The material of the hulls was still wood, which gave a platform for the machinery altogether too flexible to permit of the type of engines which we now use; consequently he designed what were known as geared engines, which he, better than any one else, knew were extremely heavy, but the great point is that they enabled him to accomplish exactly what he set out to do. The "Wampanoag," the first of these vessels, in 1868 made the unprecedented record of nearly seventeen knots for thirty-six hours in a rough sea, and for several periods of six hours, seventeen and one-half knots. At that time, no other vessel in the world, either war or merchant steamer, approached this speed within three knots.

About this time Mr. Isherwood conducted a number of experiments in connection with the expansion of steam, and boldly enunciated principles which the rest of the engineering world in many cases denounced as erroneous, but which are now accepted as fundamental facts in thermodynamics. This is notably the case with respect to cylinder condensation, where he was the first to enunciate the true principle.

Another great engineer became famous at this time, although he had been doing splendid work and helping to develop the war vessel before, namely, Captain John Ericsson. You all know the story of the first "Monitor," and it is not necessary to repeat it. I only wish to remark as apropos of my theme that here was a vessel which in hull, machinery and ordnance was the work of engineers, and which for that period represented the highest embodiment of engineering skill and talent. It is worth noting in this connection that the success of the "Monitor" in her engagement with the "Merrimac" was due almost entirely to the skill of her engineers, Stimers and Newton. They were thoroughly familiar with every detail of her machinery, which needed skill to keep it in good order, and, as is well known, after the accident to the gallant commander, Worden, Stimers fought the guns while Lieutenant Greene, the executive officer, took command in the conning tower.

I must not neglect to state that splendid work during this period was done for our ordnance; and the development of this branch of engineering, largely due to the skill and ingenuity of Admiral Dahlgren, was such that at the end of the Civil War our naval guns were recognized as the best in the world.

There now comes a period in our naval history which, as far as actual results are concerned, may just as well be passed over, for while our designers were keeping abreast of the times, we were not building anything new in either ships, guns or machinery. Beginning with 1883, however, a new era dawned for the navy, and we began the building of our White Squadron, which has so appropriately been termed the "New Navy," and in connection with these ships I shall endeavor to go into some details which will thoroughly prove the correctness of the theme which has been given me to discuss.

What is the problem that confronts the naval designer? The maximum of offense, combined also with the maximum of defense, and with a maximum of mobility. It is important to note the limitation upon the naval designer as regards one vital element, namely, weight, for this has far-reaching effects in every feature of design, and differentiates in a most marked way his work from that of a designer of somewhat similar works for use on shore.

While it has been aptly said that the war vessel is a "gun platform," and it would therefore almost seem that everything else must be subordinated to securing a maximum gun fire, the vessel must be prepared to withstand an attack of an opponent of equal force, which necessitates close attention to the defensive elements. Now, under the very best circumstances, the weight of the bare hull will approach fifty per cent. of the entire displacement, which, as you know, simply means the weight of the completed ship with everything on board, so that we have left only somewhat more than half of the displacement for guns, armor, ammunition, machinery, coal and stores. The first problem then is to construct a hull which shall safely carry all the weights, and do so with a minimum amount of material. This is a problem where the skill and ingenuity of the static engineer, for such the naval architect really is, has great room for exercise, and we see it carried out in the disposition of material in shapes which both theory and practice have shown to give the greatest strength for least weight. We see it also in the careful arrangement of frames, keelsons, longitudinal and transverse bulkheads, plating and deck stringers, while the protective deck (popularly supposed to be only for keeping out projectiles) also becomes in the hands of a skilled designer an important element of strength.

The ship must also be unsinkable, or at least as nearly so as possible, and this has led to the subdivision into watertight compartments, and great ingenuity has been displayed in devising schemes for watertight doors, which are absolutely necessary to give access from one compartment to another, but which, unless very carefully designed and constructed, may, in time of need, be a source of danger instead of safety. The latest developments in protection against submersion have taken the form of a belt of cellulose, a material which, when perforated by shot and exposed to water, immediately swells up and excludes a further inrush.

Great skill and ingenuity must also be displayed in the proper adjustment of weights to secure correct trim, and this in connection with the form of the ship must be such as to give ample stability, combined with steadiness of gun platform. This is an instance where the modern war vessel is a vast improvement on those of years ago, when the question whether a ship would be an easy or a hard roller was almost entirely a matter of luck. Now it is a matter of calculation and design, and the skillful naval architect is able to guarantee a vessel which will withstand any storm, be comfortable as regards motion, and provide a steady platform for the guns.

We may also note in this connection that the modern war vessel is a striking example of what ingenuity and skill can do to make habitable and comfortable compartments that are at best meager and crowded. We ordinarily consider light, water and air as synonymous with what is free and obtainable without effort, yet on the modern war vessel all these elements are due to the skill of the engineer. In place of the tallow candle of our forefathers, we now have the electric light. In place of the casks of water many days old and far from palatable, we have absolutely pure and sparkling distilled water, which has contributed enormously to the excellent health of our crews, as was brought to the public attention in a most marked way during our recent war with Spain, when the crews of our naval vessels had hardly a man on the sick list, while the armies had enormous numbers ineffective. With its numerous bulkheads dividing it into small compartments, the modern war vessel can have no natural circulation of air, and the engineer provides pure air by artificial means. Steam radiators also make both officers and men comfortable in any kind of weather.

As a final item in connection with this branch of the subject, we may mention the remarkable development of scientific knowledge, ingenuity and skill in the production and determination of powers and speeds for large vessels from experiments on small wax models. Here we have combined the work of the mathematician and the physicist in working out the laws and formula involved, and the skill of the engineer and mechanician in the design and manipulation of the apparatus.

Turning now to the question of guns and armor, we have a most marked illustration of the accuracy of our theme. At the close of the Civil War our guns were still principally cast iron smoothbores. Progress has changed all this into the modern, high-powered steel breech-loading rifle, weighing many tons and driving at immense velocity a projectile whose encounter with an obstacle may be truly likened to that of one of Jove's thunderbolts. The stress coming upon the metal in one of these guns is as great as can possibly be allowed with safety, and the demands for greater powers have called for all the skill of the metallurgist, combined with the ingenuity and talent of the engineer, in so disposing the metal as to get maximum results with minimum weights. The latest development in these guns, consisting of what is known as the "wire-wound gun," is extremely interesting as showing how a form of construction which at first sight might seem anything but the best is nevertheless the disposition of material which theory shows is most desirable and practice thoroughly confirms.

It will doubtless interest you to hear a few figures of the performance of some of these great guns. The latest authorities state that a 12·5-inch breech-loading rifle, 50 calibers long, and weighing 83 tons, will propel a shell weighing 880 pounds, by a powder charge of 624 pounds, at a velocity of over 2,620 feet per second, giving an energy at the muzzle of over 40,000 foot-tons, capable of penetrating at the muzzle over 45 inches of iron. This energy means that one of our battleships of about 12,000 tons displacement, and which could carry four of these guns, would at a single discharge develop a power sufficient to lift her bodily nearly 15 feet. It can readily be imagined, therefore, what the effect of a projectile from one of these guns would be when striking another vessel at close range.

It is an extremely interesting story to read of what has been aptly called the "duel between guns and armor." As fast as one is improved so that its victory over the other seems assured, some inventor comes to the front with an improvement in the latter, which for a time puts it ahead. The armor on our monitors during the Civil War consisted simply of a number of one-inch plates bolted together. At the present day a modern projectile would go through such armor as easily as a bullet penetrates pine boards, but long ago it was discovered that a given thickness of armor was much more efficient if rolled in a solid plate, and this was developed until some of the older English battleships had iron armor as thick as 24 inches. The development of the gun soon showed that it was impossible to keep pace with it by mere additions to the thickness of the simple armor, for a point was quickly reached where it was impossible to carry the necessary weight of armor that would be thick enough. Then came the use of special plates; the compound armor, where a hard face to break up the projectile was welded to a softer back to give the necessary strength. This was followed by steel armor, and then by the well-known Harvey process, which resembled the compound armor in having a hard face with a softer back, but where the plates were made from a single ingot without any welding. The Harvey process enabled an enormously greater resistance to be obtained with a given weight of armor, but even it has been surpassed by the Krupp process, which enables 12 inches thickness to give the same resistance as 15 of Harveyized plates.

In connection with armor plates great skill and ingenuity has been necessary to provide for giving them the proper shape and for enabling necessary machine work to be done on them after they are in position, inasmuch as the hardening process makes it practically impossible to do any work on the face of the finished plates with ordinary tools. Here an application of electricity for giving a local annealing where it was necessary to work with tools, enabled the solution of this problem.

The work of the artillerist is not confined to the design and manufacture of the guns and armor alone, but the gun carriages are also important features of this work, and here there has been a great display of skill and ingenuity in devising means for the ready manipulation of these ponderous masses, and the control of the recoil due to the enormous development of energy when the gun is discharged. This is true both of the manipulation by hand and the control of the turn-tables, or turrets, for the larger guns; and the ease with which a turret and its contained guns, weighing several hundred tons, can be controlled by a single lever so that the pointing of the gun is almost as simple as that of an ordinary musket, is really surprising.

The chemist has also had an important part to play in connection with ordnance work, in the development of powders which would enable the enormous energy necessary to be developed with safety to the structure of the gun. With the powder used during our Civil War it would be impossible to get the results of to-day. The development has been through what were known as slow-burning powders down to the smokeless powders of to-day, where the saltpeter and

* Address delivered by Rear Admiral George W. Melville, Engineer-in-Chief, United States Navy, on the occasion of the seventy-fifth anniversary of the founding of the Franklin Institute, October 7, 1899.

charcoal of our ancestors have been displaced by the combination resulting from the treatment of cotton with nitric acid. The difference in the energy of the ordinary slow-burning powder and of the smokeless powder now used can be seen by consulting any table where the two are compared. One which I recently examined showed that guns, otherwise practically identical, required with the same weight of projectile three times the weight of ordinary powder to get the same velocity as with smokeless powder.

We must not forget, while discussing ordnance, the remarkable development of what are known as "quick-firing guns." This, as you know, is really the adaptation to large guns of the kind of ammunition and breech mechanism used on the modern small arms, and it has been carried so far that modern quick-firing guns are now made of as large caliber as eight inches, giving a muzzle energy of over 10,000 foot-tons, while the number of times the gun can be discharged in a given interval is about double that of the ordinary breech-loader. In the smaller sizes of these quick-firing guns the rapidity of fire is almost incredible, and I remember being particularly struck by the results of repeated trials showing that it was possible from a six-pounder to have five projectiles in the air at once.

More than a quarter of a century ago what are now known as machine guns were introduced; that is, weapons of small caliber approximating to that of ordinary small arms and slightly larger were so arranged that the ammunition could be fed almost continuously and the rapidity of fire be so great that a single weapon would be equal to a company of soldiers. As you are doubtless aware, the Gatling gun was the earliest of these. These, too, have been developed during the intervening years, until it would seem that finality has almost been reached in the Maxim gun, where when once started it continues to discharge itself by the effect of its own recoil, until the old metaphor "iron rain and leaden hail" becomes a simple matter of fact. The Maxim gun will fire 600 shots per minute from a caliber of 0·45 inch or less.

We come now to the machinery of the modern vessel, and I trust that you will pardon me if I go into greater detail here, because this is my own special field and one where it has been my lot to have been intimately associated with the construction of our new fleet. Here, more than almost anywhere else in the war vessel, the constant demand has been for greater power on less weight, and at the same time the demand has also been for thoroughly reliable machinery that would also be economical.

Progress has been so rapid that it sometimes seems that we hardly have time to get out a design as nearly perfect as possible and see it thoroughly tested in service before improvements have been suggested that render what appeared so perfect relatively obsolete.

Shortly before I became Engineer-in-Chief of the Navy, forced draught had been reintroduced, after many years of disuse, which at once gave an enormous increase of boiler power with a very slight increase of weight, due to the burning of a much larger amount of coal on a given grate surface. The shell boiler was developed until its design seemed nearly perfect, but we were confronted with the problem of getting plates sufficiently thick to withstand the increasing steam pressures in the large boilers and still be able to properly work the plates in our shops. The weight of these boilers was always very great for the power developed, and in the large sizes which they had reached the utmost skill was necessary for their proper care and maintenance. Shortly before the time had come when further progress with the shell boiler seemed impossible, the water-tube boiler was developed to such a point that it gave us the necessary solution of the problem, and it now seems quite certain that, for some time to come at least, the boiler problem has resolved itself into a determination of the best form of water-tube boiler, inasmuch as we are now sure that we can construct boilers which will withstand any pressures that are likely to be used and which are satisfactory in every other respect. These boilers offer almost absolute safety against disastrous explosion, afford a great reduction in weight, and are built to withstand comparatively rough treatment as far as heat is concerned, thus giving freedom from such troubles as leaky tubes and leaky seams, to which large shell boilers were very liable.

The demand for reduction of weights in the engines has been met by the use of stronger materials, and also their disposition in shapes where a given weight of material offers the greatest resistance.

We thus have steel castings to replace cast iron; hollow forgings of oil-tempered steel, and the uses of bronzes of double the strength of the older compositions. Besides the greater strength of the materials, just as important an item is their much greater reliability. Our manufacturers to-day can furnish us with forgings where we know that the results obtained on test pieces will be absolutely true of every part of the whole mass.

Weights have also been greatly reduced by using engines which run at much greater speeds than formerly obtained. This seems a sufficiently simple matter, and yet it was not possible until the improvement came in materials, combined with an accurate scientific knowledge of some of the questions confronting the marine engineer, which had formerly been solved almost by rule of thumb. This is notably the case with propeller design, for it was the mistaken notions on this point that really held down the engine speeds. Inasmuch as the whole office of the motive machinery is to turn the propellers, it might seem that it would be necessary to design the propeller first and make everything else to suit it, but, fortunately, now that we have accurate scientific knowledge of the conditions governing propeller design, we know that the propeller can be arranged to suit almost any speeds found desirable for the engines, and this enables us to choose engine speeds which will give us both lighter and more economical ones than were possible in olden days.

A problem in the design of engines for war vessels which is of considerable difficulty, and the solution of which is not yet thoroughly satisfactory, is that of securing economical results at ordinary cruising speeds, with the capacity for the power necessary at maximum speeds. As you are doubtless aware, the power necessary to drive a vessel varies approximately as the cube of the speed, so that if, as is ordinarily the case, the cruising speed is about half the maximum, the power to be developed is one-eighth or less of the maximum. As was very cleverly expressed by one of my former assistants (Prof. Hollis) some years ago, the problem is like that of having a beast of burden whose maximum power will be that of an elephant, but whose appetite is so adjustable that he could be economically used for work which could be performed by a donkey. You well know that an elephant would eat about the same whatever work he was doing, and while this is not exactly true of a steam engine, it nevertheless is true that its economy when worked at powers which are such a small percentage of the maximum is very much reduced. In some of our ships we have tried to solve this by arranging two sets of engines on each shaft, so that at the moderate powers the forward set can be uncoupled. The ill-fated "Maine" had an arrangement whereby the large cylinders of her triple expansion engines could be disconnected, leaving the engines to run as smaller compounds at cruising speeds. A somewhat similar arrangement is in use on the "Nashville," where the large cylinder of a quadruple expansion engine can be thrown out, leaving a triple expansion for lower powers. The objection to all of these is that if it becomes necessary in an emergency to get full power, it is often impossible to stop to couple up. This was exemplified in a marked way in the case of the "Brooklyn" during the fight at Santiago. She was cruising with her after engines only when Cervera's fleet came out, and it was felt that there was not time to stop to couple up, which would have necessitated from twenty minutes to half an hour. The distribution of the power among more than two shafts offers another solution, which was used on the "Columbia" and "Minneapolis." Personally I believe that this system, if properly carried out, would be entirely satisfactory, but it would involve the use of the center screw only for ordinary cruising, and a ship, as you doubtless know, is not so handy with one screw as with two. Our latest design to meet the desire to use two screws and still get relatively small engines for cruising speeds is to use three screws but make the engine driving the center one-half the total power, leaving each of the wing screws to develop only a quarter of the full power. We have not as yet built any vessels on this plan, so that while theoretically we have every reason to anticipate entire success, it has not as yet been tried in practice.

A very interesting illustration of the application of ingenuity and scientific knowledge is the method adopted for balancing the engines so as to avoid vibration of the hull. As engine speeds and hull dimensions increased, there came a combination of circumstances, causing excessive vibration of the hull, due to unbalanced inertia stresses of the reciprocating parts of the engines. The solution is a very simple adaptation of a type of engine desirable for other reasons with a special arrangement of crank angles and weights of reciprocating parts. The adoption of the steam turbine has also been suggested to accomplish this same object, and turbines have been employed on some torpedo boats. With certain very promising features, there are, however, some great disadvantages, and before the steam turbine becomes a formidable rival of the ordinary type of engine an enormous amount of skill and ingenuity must be exercised, and the lines along which they can act are not yet apparent.

I have already referred to the three vital elements in warship design as offense, defense and mobility, and the best combinations of these features to secure maximum results tax the judgment and experience of the designer, as well as his skill and ingenuity. If time permitted, it would be of the greatest interest to show how the necessity of maximum results in particular items has given us special classes of vessels. Thus in the battleship, which must give and take heavy blows, mobility or speed has been sacrificed, while in the armored cruiser both guns and armor have been reduced to secure high speed. In the torpedo boat, speed is absolutely vital and everything else is sacrificed to it. The tendency just now seems to be along the line of having only one class of armored vessels, which will be very powerful armored cruisers with good armor protection and high speed. This means a vessel of about 12,000 to 14,000 tons displacement, with 8 to 10 inches of Krupp armor, a battery of 10-inch rapid-fire guns, and a speed of about 20 to 21 knots.

We have now given a hasty glance at the principal elements of the modern war vessel, although I regret that the limited time at my command has forbidden the consideration of many features which could not have failed to be of interest to you, such as the workshops on board where the necessary routine repairs are made to keep the great machine in working order; the electric installation for lighting the various portions of the ship and providing the searchlights; the elaborate drainage system with the necessary pumps; and the torpedoes, with their wonderfully intricate and delicate machinery, which is so arranged as to work automatically after being discharged from the ship, in a way that would seem to indicate human control at every moment. I trust, however, that you will have heard enough to satisfy you that the theme of my remarks is fully borne out by the facts which have been adduced.

The truth is, that in every department of life there has been a tremendous advance, due to the exercise of skill, ingenuity, and scientific knowledge, with which the modern war vessel has thoroughly kept pace. A moment's reflection would, of course, make it very clear to us that it would be impossible to build war vessels such as we now possess unless there had been a corresponding development in every other manufacturing industry. Governor Roosevelt, when Assistant Secretary of the Navy, touched upon a very important matter connected with this subject in discussing what was known as the "Personnel Bill." In comparing the development of naval science to the point where it became necessary for every officer in the navy to be an engineer, so that it is necessary for the modern admiral to know many things of which our great Farragut, for example, was ignorant, he said that it would, of course, require vastly greater skill to handle the complicated mechanism which the modern war vessel is than one of the old ones, but that, just as we had always been able to produce competent men to handle the less complicated vessels of former times, so without doubt we would get competent men to handle those of to-day. He had learned the fact that the modern warship is a vast engine, and to be properly controlled must be handled by engineers. Congress has in the Personnel Bill provided and directed that, as soon as we can make the necessary arrangements, every officer in the navy charged with the handling of a vessel shall be a trained engineer, and, therefore, we may be sure that however complicated and delicate the organisms of the machine become, we shall have officers who, by education and experience, are fitted to properly care for the valuable and delicate machines intrusted to them.

I have had a part in two wars, in both of which the navy played an important part and became dear to the people, and I have also passed through the intervening interval, during much of which the navy seemed to be entirely forgotten. I sincerely trust that as the late war showed we not only know how to build good ships but to make them go and to fight them, our fellow citizens in civil life will see to it that the navy is maintained in a state of the highest efficiency, both as to personnel and material, ever ready for efficient use when needed. In this work, which on both sides is a matter for engineers, this institute has a vital interest, and I trust that, just as your influence has for seventy-five years been on the side of the general advancement of engineering in the mechanic arts, so it will be on the side of their advancement in the navy.

THE CHARGING AND CARE OF AUTOMOBILE BATTERIES.

By Theodore D. Bunce.

It is certainly not necessary that the owner of an electric automobile should be thoroughly acquainted with every detail of the construction of his vehicle, both mechanical and electrical, any more than we would expect every driver of a horse to be a veterinarian. But if every owner were as conversant with the general makeup and needs of his machine as the experienced driver is in the care and handling of his horse this article would be uncalled for. It is probable that the majority of automobile owners will not care to study the scientific construction of the batteries that furnish the power for their machines, but they will wish to have a practical knowledge of their working.

In a general way the battery of the automobile may be compared with the horse. Both may be overworked with more or less disastrous results. The battery may, like its equine rival, be over as well as under fed, the latter condition in both being worse than the former. Both are the better off when not subjected to sudden starts, and both will last longer if not constantly pushed to their utmost capacity. Both renew their strength and usefulness after a reasonable rest, and last, but not least, both require when ill the care of an expert—the horse the veterinary surgeon and the battery the skilled electrician.

The motor, while forming an important part of the mechanism, is more a part of the vehicle proper than the battery, and receives attention with the general care of the machine. It is not intended in this article to discuss the construction or care of the motor, but to explain in a practical manner the battery, as it is the vital part of the mechanism. The general features of the battery should be understood by the owner or driver in order to obtain the best service and to economize the power.

The storage battery of an automobile usually consists of 40 to 44 cells, generally divided into four groups of 10 or 11 cells each. Each cell gives from 2½ volts when fully charged to 1·75 volts each when it has arrived at the lowest potential it should be allowed to reach on discharge. This gives a maximum of from 100 to 110 volts and a minimum of from 70 to 77. As the majority of direct current circuits that would be used for charging are from 110 to 120 volts pressure, it is readily seen why 40 cells is the best number to use, as the 110-volt circuit will always give the necessary excess of pressure required to force the current through the cells, at the same time requiring the least amount of resistance for regulating.

In the majority of automobiles the change of speed is effected by grouping the cells in sets. It is for this reason that a multiple of four is used for the total number. Thus $44 \div 4 = 11$, or $40 \div 4 = 10$. The mechanism for operating takes care of this grouping. It will be found on removing the cells from the vehicle that each set of 10 or 11 cells are permanently connected in series—that is, the positive of one cell to the negative of the next, and so on. In the vehicle each set is connected either automatically or otherwise to the wires leading to the controller.

In charging, all the sets should be connected in series—that is, the four groups connected together, the positive of one group to the negative of the next. This is generally provided for by the manufacturer of the vehicle when the battery is to be charged in the vehicle. It is generally accomplished by disconnecting the motor wires and setting the controller at full speed. This is obvious, as all the cells are used in series when the full power is to be developed. It is important, however, to remember to disconnect the motor wires before turning the controller to full speed. If it is desired to charge the cells independently of the vehicle, or an individual test of the cells is to be made, they may be removed and connected in series, leaving a positive pole at one terminal and a negative at the other. The positive pole is generally indicated either by a + sign or by a red mark. The negative pole is sometimes indicated by a — sign, but it is more frequently unmarked.

Up to this point we are considering the cells in groups properly marked by the manufacturer, and the individual polarity of each cell may be disregarded until we have occasion to remove them from the group.

The electrolyte or fluid used in the cells is a mixture of sulphuric acid and water. The strength of this solution varies with the state of charge of the battery. When the cells are fully charged the solution is at its maximum strength, and becomes weaker in proportion to the amount of current taken out. The solution does not require replacing except when the cells are to be dismantled for cleaning or repairs. There should always be sufficient in the cells to cover the tops of the plates, as any portion left exposed is inactive and will deteriorate rapidly. There will always be a slight loss by evaporation or spilling, but this may be replaced by the addition of clean water. But should any con-

siderable amount be required, it is better to add acid, in order not to weaken the electrolytes. The plugs in the covers of the cells should be removed and the necessary water added to replace evaporation. A special rubber bulb with a small nozzle is made for this purpose.

The solution is a mixture of sulphuric acid and water of 22° by Baumé hydrometer, or a specific gravity of 1·180. Preparing with a hydrometer is better than mixing by measure or weight, as the density of the pure acid may vary. With the commercial acid the proportions by measure are 1 part sulphuric acid and 5 parts water. The solution should be made in a stone vessel or lead-lined tank. Put a sufficient quantity of water in the vessel and slowly pour in the acid, stirring it constantly with a glass rod or a piece of wood. The solution gets hot and becomes stronger as it cools. Test it with the hydrometer, and if it is of about 20° let it stand until cold, when either acid or water may be added to make it the exact strength required. Do not let the acid come in contact with any metal but lead. The pure acid is exceedingly corrosive, and the prepared solution will destroy clothing if not neutralized at once by ammonia or some other alkali.

As it is impossible to use the hydrometer in the batteries made for automobile work, it will be necessary to withdraw some of the acid with a suction bulb or syringe, and a test made in a separate vessel. A convenient instrument is made for this purpose, called a hydrometer syringe. It is a combination of a suction bulb and a tube holding the hydrometer. As long as the cells are working uniformly it is not necessary to make any change in the acid, but should any cells be found of a low voltage, the acid will be correspondingly weak, and it may be difficult to make it recover its original strength by charging. If fresh solution is put in it should be diluted after the cell has been restored by charging, as the acid will then be found too strong. In no case ever pour the pure acid into the jar containing the plates.

The charging wires should be run to a convenient switchboard and should be connected to an ammeter, a rheostat, a main switch and the customary fuse block. The rheostat should be of large enough capacity to carry the maximum charging rate without overheating, and should have a sufficient number of steps for the regulation of the current. The polarity must be determined and the poles properly marked. If there is any possibility of the polarity being changed, a test with a polarity indicator should be made each time before turning on the current.

In most cases the cells will be charged in the wagon, and the directions given by the manufacturer should be followed. The charging plug furnished with the wagon should be attached to a cable of convenient length and the ends connected to the terminals on the switchboard. The polarity at the plug should then be tested and made to correspond with the marks on it. It is then inserted in the receptacle on the wagon. The rheostat is set with all the resistance in circuit and the current turned on. If plenty of time can be allowed in which to charge, the normal rate should be adhered to; but if it is necessary to hurry the charging, the maximum may be applied at first and then reduced as the cells begin to show signs of being charged.

As soon as the bubbles rise to the surface of the acid freely or the sound of bubbling can be plainly heard, the current should be reduced step by step as the bubbling continues, and if at the lowest point it still continues, it is evident the cells are nearly charged. It is advisable to continue charging at a low rate, as there may be some cells below the others, and they will have an opportunity to catch up, while an over-charge at a low rate will not injure the others.

If a battery has been over-discharged it will be necessary to continue the charge for a longer time, as even the bubbling will not be a sure indication of its being up to its full capacity. In the latter case the battery should be taken out of the vehicle and the plugs removed from the cells, so that each cell can be inspected. The gas that forms from the bubbling is explosive, so as much ventilation should be given as possible, and great care should be taken to have no fire allowed near. The cells should be examined by an incandescent lamp. They should all bubble uniformly on a low rate of charge.

After a heavy over-discharge even a prolonged charge will not always bring the cells back to their original condition, but if the following discharges are moderate the subsequent chargings will restore them. It is always advisable to charge the battery as soon as possible after it has been used, and if convenient give it a short charge shortly before taking out the vehicle.

When an automobile is used every day, two sets of batteries will be found of advantage, as there will be more opportunity to give them attention and a longer time to charge. In any case, frequent tests of the cells are recommended, as a fault once developed in a cell will become worse and lead to further trouble if not repaired at once.

We have endeavored to cover the principal points in the care of automobile batteries. Much more could be said of a technical nature. Other currents than the 110-volt circuit may be used for charging, but with the increase in the number of vehicles and charging facilities they will rarely be called upon.

A storage cell is made up of two groups of plates, called positive and negative. Each group has attached to it a connecting strip of lead. The plates alternate in the jar, so that one plate is of opposite sign to the next. They are kept from touching by various methods of insulation that allow of a free circulation of the solution. When the charging current passes in at one pole it reaches the next through the solution and effects a chemical change in the nature of the plates. When this chemical change is complete the cell is fully charged, and when the circuit is closed a reaction takes place and a chemical change of an opposite character occurs. This produces an electric current. No electricity is actually stored.—Horseless Age.

At Marquette, Michigan, a 35-foot lifeboat has been equipped with a 12 horse power engine in an air-tight chamber. The engine was kept steadily running during the test, which involved the rolling over and over of the boat. The presence of the engine did not interfere with the self-righting ability of the boat, which made 7 miles per hour when on an even keel.

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